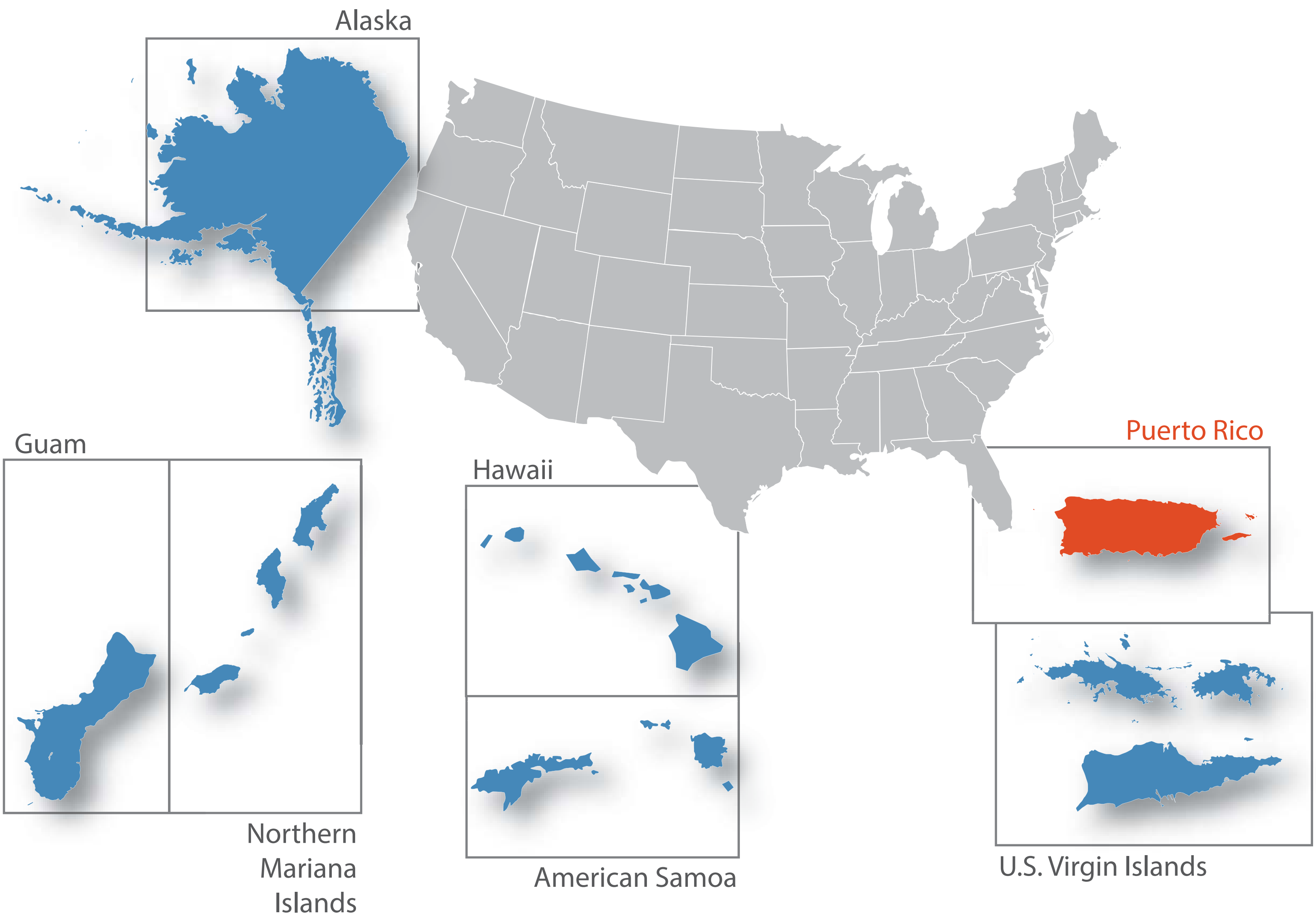
Nationwide Public Safety Broadband Network
Final Programmatic Environmental Impact Statement for the Non-Contiguous United States

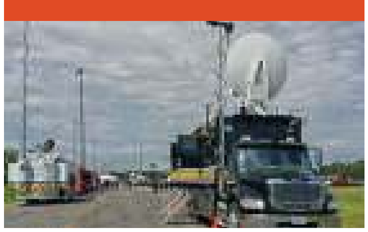
FirstNet®

First Responder Network Authority

Volume 6 - Chapter 8

Alaska
Hawaii
American Samoa
Guam
Northern Mariana Islands
Puerto Rico
U.S. Virgin Islands



May 2017

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First Responder Network Authority

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Volume 6

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Cooperating Agencies
Federal Communications Commission
General Services Administration
U.S. Department of Agriculture—Natural Resource Conservation Service
U.S. Department of Agriculture—Rural Utilities Service
U.S. Department of Agriculture—U.S. Forest Service
U.S. Department of Commerce—National Telecommunications and Information Administration
U.S. Department of Defense—Department of the Air Force
U.S. Department of Energy
U.S. Department of Homeland Security

May 2017

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ACRONYMS AND ABBREVIATIONS

°F	degree Fahrenheit
°N	degrees north
$\mu g/m^3$	microgram(s) per cubic meter
μPa	micro Pascal
%	percent
A	attained
AAC	Alaska Administrative Code
AAFIS	Alaska Public Safety Identification System
AAQS	Ambient Air Quality Standards
ACHP	Advisory Council on Historic Preservation
ACS	American Community Survey (U.S. Census Bureau)
ADEC	Alaska Department of Environmental Conservation
ADFG	Alaska Department of Fish and Game
AGL	above ground level
AIRFA	American Indian Religious Freedom Act
AJRCCM	American Journal of Respiratory and Critical Care Medicine
AKNHP	Alaska National Heritage Program
AKOSH	Alaska Occupational Safety and Health
AKWAS	Alaska Warning System
ALMR	Alaska Land Mobile Radio
ANCSA	Alaska Native Claims Settlement Act
ANFIRS	Alaska Fire Incident Reporting System
ANSI	American National Standards Institute
APE	Area of Potential Effect
APLIC	Avian Power Line Interaction Committee
APSIN	Alaska Public Safety Information Network
AQCR	air quality control region
ARFF	Aircraft Rescue and Firefighting
ARMS	Alaska Records Management System
ARPA	Archaeological Resources Protection Act of 1979
AS	Alaska Statute
ASAC	American Samoa Administrative Code
ASCA	American Samoa Code Annotated
ASCMP	American Samoa Coastal Management Program
ASDHS	American Samoa Department of Homeland Security
ASDMWR	American Samoa Department of Marine and Wildlife Resources
ASEPA	American Samoa Environmental Protection Agency
ASHPO	American Samoa Historic Preservation Office
ASPA	American Samoa Power Authority
ATO	Air Traffic Organization
ATWC	Alaska Tsunami Warning Center
AURORA	Alaska Uniform Response Online Reporting Access
BACT	best available control technology
BCE	before Common Era
BCR	Bird Conservation Regions
BGEPA	Bald and Golden Eagle Protection Act
BLM	Bureau of Land Management
BLS	U.S. Bureau of Labor Statistics
BMP	best management practice
BRFSS	Behavioral Risk Factor Surveillance System
BSAI	Bering Sea/Aleutian Island
BWG	BioInitiative Working Group
CAA	Clean Air Act
CAB	Clean Air Branch
CARB	California Air Resources Board
CBIA	Coastal Barrier Improvement Act of 1990
CBRA	Coastal Barrier Resources Act of 1982
CCP	Comprehensive Conservation Plan
CDC	Center for Disease Control
CDLNR	Commonwealth Department of Lands and Natural Resources
CE	Common Era
CELCP	Coastal and Estuarine Land Conservation Program
CEPD	Caribbean Environmental Protection Division
CEQ	Council on Environmental Quality
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFMC	Caribbean Fisheries Management Council
CFR	Code of Federal Regulations
cfs	cubic feet per second
CH_4	methane
CHC	Commonwealth Health Center
CIA	Central Intelligence Agency
CMIP3	Coupled Model Intercomparison Project phase 3
CNMI	Commonwealth of Northern Mariana Islands
CNMIAC	Commonwealth of Northern Mariana Islands Administrative Code
CO	carbon monoxide
CO_2	carbon dioxide
CO_2e	carbon dioxide equivalents
COMAR	Committee on Man and Radiation

CPA	Commonwealth Ports Authority
CRMP	Coastal Resources Management Program
CSP	Central South Pacific
CUC	Commonwealth Utilities Corporation
CWA	Clean Water Act
CZMA	Coastal Zone Management Act
CZMP	Coastal Zone Management Program
DACA	Deployable Airborne Communications Architecture
DAR	Division of Aquatic Resources (Hawaii)
DAWR	Division of Aquatic and Wildlife Resources (Guam)
dB	decibel(s)
dBA	A-weighted decibel(s)
DBCP	1,2-dibromo-3-chloropropane
dBZ	Z-weighted decibel(s)
DCP	1,2-dichloropropane
DEC	Department of Environmental Conservation
DHHL	Department of Hawaiian Homelands
DLNR	Department of Land and Natural Resources (Hawaii)
DMA	Disaster Mitigation Act of 2000
DNER	Department of Natural and Environmental Resources of Puerto Rico
DOA	Department of Agriculture
DOD	Department of Defense
DOE	U.S. Department of Energy
DOH	Department of Health
DOH-CAB	Hawaii Department of Health, Clean Air Branch
DOT	U.S. Department of Transportation
DPNR	Department of Planning and Natural Resources (U.S. Virgin Islands)
DPS	Department of Public Safety
EA	Environmental Assessment
EAS	Emergency Alert System
EBS	Emergency Broadcast System
EDB	ethylene dibromide
EFH	essential fish habitat
EMS	emergency medical services
ENSO	El Niño/Southern Oscillation
EO	Executive Order
EPCRA	Emergency Planning and Community Right-to-Know Act
ERP	effective radiated power
ESA	Endangered Species Act
ESI	Environmental Sensitivity Index
FAA	Federal Aviation Administration
FAD	Fish Aggregating Device
FCC	Federal Communications Commission
FEMA	Federal Emergency Management Agency
FirstNet	First Responder Network Authority
FMP	Fishery Management Plan
FPPA	Farmland Protection Policy Act of 1981
FR	Federal Register
ft	feet
g/hp-hr	grams per horsepower-hour
g/mi	grams per mile
GAP	Gap Analysis Program
GCA	Guam Code Annotated
GDA	Guam Department of Agriculture
GEPA	Guam Environmental Protection Agency
GHG	greenhouse gas
GIS	geographic information system
GMP	General Management Plan
GOA	Gulf of Alaska
GRHP	Guam Register of Historic Places
GWP	global warming potential
H_2S	hydrogen sulfide
HDOH	Hawaii Department of Health
HEI	Health Effects Institute
HHCA	Hawaiian Homes Commission Act of 1920
HI-EMA	Hawaii Emergency Management Agency
HIANG	Hawaii Air National Guard
HIARNG	Hawaii Army National Guard
HIHWNMS	Hawaiian Islands Humpback Whale National Marine Sanctuary
HIOSH	Hawaii Occupational Safety and Health Division
hp	horsepower
HRD	(Guam) Historic Resources Division
HRHP	Hawaii Register of Historic Places
HRS	Hawaii Administrative Rules, Revised Statute
HTA	Hawai'i Tourism Authority
HUC	hydrologic unit code
I/M	Inspection/Maintenance
IARC	International Agency for Research on Cancer
IBA	Important Bird Area
IEEE	Institute of Electrical and Electronics Engineers
IFC	International Finance Corporation
in	inches
IPCC	Intergovernmental Panel on Climate Change
IR	ionizing radiation
ITCZ	Intertropical Convergence Zone
IUCN	International Union for Conservation of Nature
kg/gal	kilograms per gallon
KIRC	Kaho'olawe Island Reserve Commission

LAER	lowest achievable emission rate
lb/day	pounds per day
lb/hp-hr	pounds per horsepower-hour
LBJ	Lyndon B. Johnson
Ldn	day-night average sound level
Leq	equivalent noise levels
LNG	liquefied natural gas
LTE	Long Term Evolution
$\mu g/m^3$	microgram(s) per cubic meter
µPa	micro Pascal
m/s	meter per second
MBTA	Migratory Bird Treaty Act
mg/m^3	Milligram(s) per cubic meter
mgd	million gallons per day
MHz	megahertz
MLRA	Major Land Resource Area
mm/s	millimeters per second
MMPA	Marine Mammal Protection Act
MOA	Memorandum of Agreement
MPA	Marine Protected Area
mph	miles per hour
MSA	Magnuson-Stevens Fishery Conservation and Management Act
MTR	Military Training Route
MUID	Map Unit Identification Data
MW	megawatt
mW/cm^2	milliwatts per centimeter squared
N	north; not attained
N_2O	nitrous oxide
NA	not applicable; not assessed
NAAQS	National Ambient Air Quality Standards
NAGPRA	Native American Graves Protection and Repatriation Act
NANSR	Nonattainment New Source Review
NAWAS	National Warning System
NCA	National Climate Assessment
NCD	non-communicable disease
NCDC	National Climatic Data Center
NCN	no common name
NCRP	National Council on Radiation Protection and Measurements
ND	no data
NE	northeast
NEPA	National Environmental Policy Act
NESHAP	National Emission Standards for Hazardous Air Pollutants
NFIP	National Flood Insurance Program
NFIRS	National Fire Incident Reporting System
NHPA	National Historic Preservation Act
NIR	non-ionizing radiation
NMFS	National Marine Fisheries Service
NMHC	non-methane hydrocarbon compounds
NMOG	non-methane organic compounds
NNE	north-northeast
NOAA	National Oceanic and Atmospheric Administration
NOx	nitrogen oxides
NP	National Park
NPDES	National Pollutant Discharge Elimination System
NPL	National Priorities List
NPS	National Park Service
NPSBN	nationwide public safety broadband network
NRCS	Natural Resources Conservation Service
NRHP	National Register of Historic Places
NSPS	New Source Performance Standards
NTIA	National Telecommunications and Information Administration
NVSR	National Vital Statistics Report
NWI	National Wetland Inventory
NWR	National Wildlife Refuge
NWWS	National Weather Wire Satellite System
OHA	Office of History and Archaeology
OIA	Office of Insular Affairs (USDI)
OSHA	Occupational Safety and Health Administration
PA	Programmatic Agreement
PAG	Port Authority of Guam
PAHO	Pan American Health Organization
PCB	polychlorinated biphenyl
PCP	pentachlorophenol
PCS	Personal Communications Service
PDO	Pacific Decadal Oscillation
PEIS	Programmatic Environmental Impact Statement
PL	Public Law
PM	particulate matter
PM_{10}	particulate matter up to 10 micrometers in diameter
$PM_{2.5}$	particulate matter up to 2.5 micrometers in diameter
POPs	points of presence
ppm	parts per million
PRDNER	Puerto Rico Department of Natural and Environmental Resources
PREQB	Puerto Rico Environmental Quality Board
PR OSHA	The Puerto Rico Occupational Safety and Health Administration
PRASA	Puerto Rico Aqueduct and Sew Authority
PREPA	Puerto Rico Electric Power Authority
PRSHPO	Puerto Rico State Historic Preservation Office
PSD	Prevention of Significant Deterioration
PUAG	Public Utility Agency of Guam
Pub. L.	Public Law

PV	photovoltaic
RAN	radio access network
RCP	Representative Concentration Pathway
RCRA	Resource Conservation and Recovery Act
RF	radio frequency
RIN	Regulation Identification Number
rms	root mean square
ROW	right-of-way
SAAQS	State Air Quality Standards
SAFETEA-LU	Safe, Accountable, Flexible, Efficient Transportation Equity Act:A Legacy for Users
SARA	Superfund Amendments and Reauthorization Act of 1986
SE	Standard of Error
SHPO	State Historic Preservation Office
SIP	State Implementation Plan
SLR	sea level rise
SMA	Special Management Area
SMS	Scenery Management System
SO_2	sulfur dioxide
SOx	sulfur oxides
SPCC	Spill Prevention, Control, and Countermeasure
SPCZ	South Pacific Convergence Zone
SPOC	State Single Point of Contact
SRES	Special Report on Emission Scenarios
SSA	sole source aquifer
STATSGO2	State Soil Geographic [Database]
SW	southwest
TAAQS	Territory Ambient Air Quality Standards
TCP	traditional cultural property
TEMCO	Territorial Emergency Management Coordinating Office
TMDL	Total Maximum Daily Load
TOC	total organic compound
tpy	tons per year
TRI	Toxic Release Inventory
TSCA	Toxic Substances Control Act
U.S.	United States
UAMES	University of Alaska Museum Earth Sciences
USACE	U.S. Army Corps of Engineers
USC	United States Code
USDA	U.S. Department of Agriculture
USDI	U.S. Department of the Interior
USEPA	U.S. Environmental Protection Agency
USFWS	U.S. Fish and Wildlife Service
USGCRP	U.S. Global Climate Change Research Program
USGS	U.S. Geological Survey
USVIDOH	U.S. Virgin Islands Department of Health
USVIPD	U.S. Virgin Islands Police Department
UVA	University of Virginia
VdB	vibration decibel(s)
VIC	Virgin Islands Code
VIPA	Virgin Islands Port Authority
VISHPO	Virgin Islands State Historic Preservation Office
VOC	volatile organic compound
vog	volcanic smog
VRM	Visual Resource Management
W	watt(s)
W/m^2	watts per meters squared
WAPA	Water and Power Authority
WHO	World Health Organization
WIMARCS	West Indies Marine Animal Research and Conservation Science
WNP	Western North Pacific
WNW	west-northwest
WPC	watts per channel
WPRFMC	Western Pacific Regional Fishery Management Council

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8. PUERTO RICO

This chapter provides details about the existing environment of Puerto Rico and potential impacts related to the Proposed Action.

Puerto Rico is believed to have been populated as early as 3000 BCE by archaic or pre-agroceramic peoples (peoples lacking pottery-making or agricultural skills) arriving by raft or canoe from Belize, south of the Yucatan peninsula (*Goyco 2014*). The first European contact with Puerto Rico was in 1493, when Christopher Columbus landed in Puerto Rico and claimed the island for Spain. Juan Ponce de Leon of Spain established the first European settlement in Puerto Rico in 1508. The first semi-autonomous Puerto Rican government was elected and put into place in 1898. Later that year, the United States (U.S.) gained control of Puerto Rico via the Treaty of Paris, and in 1952 Puerto Rico became a U.S. commonwealth (*Smithsonian.com 2007*).

General facts about Puerto Rico are provided below:

- Territory Nickname: Isle of Enchantment (Isla del Encanto)
- Area: 3,424 square miles (*CIA 2015*)
- Capital: San Juan
- Municipios:[1] 75
- Population: 3,548,397 people (*U.S. Census Bureau 2014*)
- Most Populated Cites: San Juan, Bayamon, Carolina, Ponce, and Caguas
- Main Rivers: Río de la Plata, Río Grande de Loíza, Río Bayamón, and Río Grande de Arecibo
- Bordering Waterbodies: Caribbean Sea and the Atlantic Ocean
- Notable Mountain Ranges: Cordillera Central, Sierra de Cayey, Sierra de Luquillo, and Sierra Bermeja
- Highest Point: Point Peak (Cerro de Punta) (4,389 feet) (*USGS 2009*)

Puerto Rico is located in the Caribbean Sea and is part of an island chain forming a border between the Caribbean Sea and Atlantic Ocean (see Figure 8-1). It is the smallest island within the Greater Antilles island chain. The territory consists of 75 *municipios*, legal divisions that the U.S. Census Bureau treats as equivalent to counties.

[1] The word *municipio* translates approximately to *town*; however, each *municipio* in Puerto Rico typically contains more than one settlement and/or surrounding rural areas.

Source: Map Service 2015

Figure 8-1: Puerto Rico Geography

In Puerto Rico, 75.8 percent of residents identify themselves as white and 12.4 percent identify themselves as Black or African American (*U.S. Census Bureau 2013*). Nearly all Puerto Rico residents identify themselves as Hispanic, compared to nearly 17 percent for the entire U.S. (*U.S. Census Bureau 2013*). In the U.S. Census, ethnicity refers to being of Hispanic origin. Ethnicity is independent of race; Hispanic individuals may identify themselves as one or multiple races.

The climate of Puerto Rico is tropical maritime, and warm temperatures occur year-round with an average temperature of 81 degrees Fahrenheit, average humidity of 73 percent, and average rainfall of 56.3 inches per year (*NOAA 2012*). Severe weather data recorded over the last 18 years (1996 to 2014) within Puerto Rico's municipalities include flooding, thunderstorms (i.e., marine thunderstorms, lightning, and heavy rain), tornado/funnel clouds, hurricanes, and high winds (50-plus miles per hour [mph]).

Puerto Rico is an unincorporated territory[2] and commonwealth of the U.S. administered by the Office of Insular Affairs, U.S. Office of Department of the Interior (*CIA 2015*). Puerto Rico's government is based on the Constitution of the Commonwealth of Puerto Rico, which includes a system of governance with three primary branches: legislative, executive, and judiciary. There are two legislative chambers, with all officials in both chambers holding 4-year terms: the House of Representatives (51 seats) and the Senate (27 seats) that develop laws for the island (*Rivera 2015*). The executive branch is managed by the governor who is elected by popular vote for a 4-year term with no term limits and leads a cabinet which is tasked with the execution of the laws (*Rivera 2015*). The judicial branch interprets how these laws should be applied, and consists of three bodies: Court of Appeals; First Instance Court: superior and municipal courts; and the U.S. Supreme Court (*CIA 2015*). The Puerto Rico Department of Natural and Environmental Resources is the territory's primary environmental agency. The Puerto Rico State Agency for Emergency and Disaster Management is the agency of the executive branch of the government of Puerto Rico that oversees all emergency activities that occur in Puerto Rico (*FEMA 2015*). In addition to police services, Puerto Rico relies heavily on the U.S. military for public safety and security. A Navy Operational Support Center is based in Puerto Rico (*Navy Recruiting Command 2015*). The Puerto Rico Air National Guard and the Puerto Rico Army National Guard are responsible for the protection of the people of Puerto Rico in the event of war or other natural or manmade disasters. The U.S. Coast Guard is responsible for defending maritime interests such as ports, waterways, and coastal security; marine environment protection; search and rescue; and defense readiness.

Puerto Rico has a complex geography that is prone to natural catastrophes like hurricanes, which add an extra level of challenge in ensuring adequate communication systems are in place (*Geography of Puerto Rico 2015*). "Puerto Rico lacks a real-time notification system to alert identified health care providers of a disaster event. The territory also lacks patient and victim tracking systems, a medical communication system with one layer of redundancy, and a real-time syndromic surveillance system" *(NHTSA 2009*).

[2] In U.S. law, an unincorporated territory is an area controlled by the U.S. government "where fundamental rights apply as a matter of law, but other constitutional rights are not available" (*U.S. General Accounting Office 1997*).

Puerto Rico's transportation system is made up of roads and highways, ports, and various rail systems. The automobile is the primary form of transportation. The Luis Muñoz Marín International Airport is the primary airport in Puerto Rico, providing connections to the U.S., Spain, Latin America, and the Caribbean.

Puerto Rico's current economy is focused around industry and services (*Commonwealth of Puerto Rico 2015*). In particular, manufacturing provides nearly half of the Puerto Rico's gross domestic product. The services sector also provides approximately half of gross domestic product, along with two-thirds of employment.

Puerto Rico contains a variety of federal, territory, and local (municipality) recreational lands, ranging from units of the National Park System and National Wildlife Refuges to city and municipality parks. Based on land whose ownership is specified in the *USGS 2012* dataset, the government owns approximately 11 percent of land in the territory.

This chapter contains a discussion of the Affected Environment (see Section 8.1) and Environmental Consequences (see Section 8.2) for each of the following 15 resources: Infrastructure; Soils; Geology; Water Resources; Wetlands; Biological Resources, which includes Terrestrial Vegetation, Wildlife, Fisheries and Aquatic Habitats, and Threatened and Endangered Species and Species of Conservation Concern; Land Use, Airspace, and Recreation; Visual Resources; Socioeconomics; Environmental Justice; Cultural Resources; Air Quality; Noise and Vibrations; Climate Change; and Human Health and Safety.

8.1. AFFECTED ENVIRONMENT

This section provides a description of those portions of the environment that could be affected by or could affect the Proposed Action in Puerto Rico. This information is used in the assessment of potential impacts from the Proposed Action as described in Section 8.2, Environmental Consequences; the level of detail in the description of each resource in this section corresponds to the magnitude of the potential direct, indirect, or cumulative impacts of the Proposed Action. The information presented was derived primarily from government data or reports and scientific literature. This section describes the current conditions and characteristics of distinct resources:

- Section 8.1.1, Infrastructure: existing transportation, public safety services and infrastructure, communication services, and other utilities and related emergency operational planning;
- Section 8.1.2, Soils: existing soil resources, features, and characteristics;
- Section 8.1.3, Geology: geologic features and characteristics that would be potentially sensitive to impacts from construction and operation of the Proposed Action, as well as geologic hazards that could potentially affect the Proposed Action;
- Section 8.1.4, Water Resources: surface water, floodplains, nearshore marine waters, and groundwater;
- Section 8.1.5, Wetlands: wetland resources, features, and characteristics;
- Section 8.1.6, Biological Resources: terrestrial vegetation, wildlife, fisheries and aquatic habitats, and threatened and endangered species and species of conservation concern;
- Section 8.1.7, Land Use, Airspace, and Recreation: overview of land use, airspace, and recreational facilities and activities;
- Section 8.1.8, Visual Resources: natural and human-made features, landforms, structures, and other objects;
- Section 8.1.9, Socioeconomics: demographic, cultural, economic, and subsistence conditions;
- Section 8.1.10, Environmental Justice: demographic data on minority or low-income groups;
- Section 8.1.11, Cultural Resources: known historic properties, traditional cultural properties, and places of cultural or religious significance;
- Section 8.1.12, Air Quality: existing air quality conditions;
- Section 8.1.13, Noise and Vibrations: existing noise and vibration conditions;
- Section 8.1.14, Climate Change: setting and context of global climate change effects in Puerto Rico; and historical and existing climate parameters including temperature, precipitation, and severe weather; and
- Section 8.1.15, Human Health and Safety: health profile of the population of Puerto Rico, including basic population health indicators and a discussion of any key community health and safety issues identified.

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8.1.1. Infrastructure

8.1.1.1. Introduction

This section discusses existing infrastructure in Puerto Rico. Information presented in this section focuses on existing transportation, public safety services and infrastructure, communication services, and other utilities and related emergency operational planning that could be augmented, supplemented, or otherwise affected by deployment and operation of the Proposed Action.

Infrastructure consists of the systems and physical structures that enable a population in a specified area to function. Infrastructure includes a broad array of facilities such as utility systems, streets and highways, railroads, airports, buildings and structures, ports, harbors, and other manmade facilities. Individuals, businesses, government entities, and virtually all relationships between these groups depend on infrastructure for their most basic needs, as well as for critical and advanced needs (e.g., emergency response, health care, and telecommunications). In 1988, the government of Puerto Rico created a government-owned corporation, the Authority for the Financing of the Infrastructure of Puerto Rico (Autoridad para el Financiamiento de la Infraestructura, or AFI), to provide funding support for infrastructure projects within the commonwealth (*Estado Libre Asociado de Puerto Rico 2013*).

Infrastructure is entirely manmade with a high correlation between the type and extent of infrastructure and the degree to which an area is characterized as "developed." Public safety infrastructure is any infrastructure utilized by a public safety entity[1] as defined in the Middle Class Tax Relief and Job Creation Act of 2012 (*Pub. L. No. 112-96, Title VI, 126 Stat. 156* (*codified at 47 USC § 1401 et seq.*), including infrastructure associated with police, emergency medical services (EMS), and fire services. This infrastructure includes fire and rescue departments, law enforcement precincts, medical centers and hospitals, transportation assets, and schools and libraries, which can be used as evacuation centers. First responder personnel include dispatch, fire and rescue, law enforcement, and medical professionals throughout the territory.

Utilities typically consist of the power, water, sewer, transit, and telecommunications systems that are essential to support daily operations. Changes in land use, population density, and development usually generate changes in the demand for and supply of utilities.

8.1.1.2. Specific Regulatory Considerations

The Puerto Rico Emergency Management Agency is responsible for the management and coordination of the preparedness, prevention, mitigation, response, and recovery before or after an incident or event that needs the coordination of the territory support and resources. In the event of an emergency, the Federal Emergency Management Agency (FEMA) provides assistance and aid for Puerto Rico and its local government (*FEMA 2015b*).

[1] The term "public safety entity" means an entity that provides public safety services (*47 USC § 1401(26)*).

The Puerto Rico State Agency for Emergency and Disaster Management is the agency of the executive branch of the government of Puerto Rico that oversees all emergency activities that occur in Puerto Rico (*FEMA 2015a*).

Territory agencies with regulatory or administrative authority over other Puerto Rico infrastructure are identified in the sections below.

8.1.1.3. Transportation

Puerto Rico's transportation system is able to support an annual population of approximately 4 million people. It is made up of roads and highways, ports, and various rail systems. Funds to support the transportation system in Puerto Rico typically come from local and federal government sources (*MPO 2013*).

Transportation in Puerto Rico is heavily dependent on automobile transportation and the government has developed plans to implement more public transportation in the territory (*USDOE 2003*).

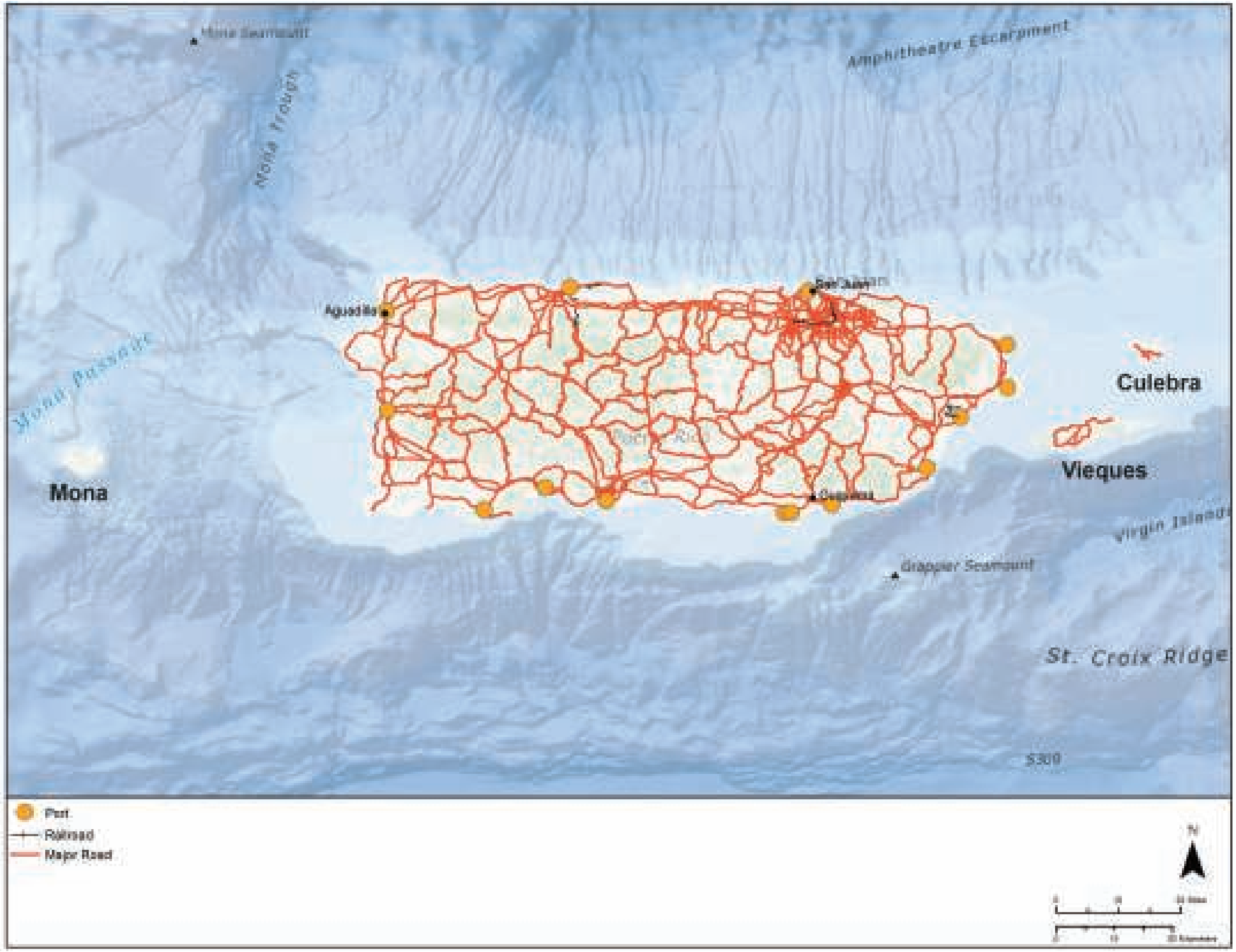
Railroads, Roads and Highways

A system of more than 8,950 miles of paved roads, highways, and tolled freeways has been developed throughout Puerto Rico, as shown in Figure 8.1.1-1 (*Business in Puerto Rico 2015*). Funding for roads and highways is received in a fashion similar to U.S. Interstates (*Business in Puerto Rico 2015*).

The two main railroads in Puerto Rico are Tren Urbano and Port of Ponce Railroad/Chemex Railroad. Tren Urbano is a 10.7 mile, fully automated passenger train service between various points of the San Juan Metropolitan Area, including Bayamón, Guaynabo, and several important sections of San Juan (see Figure 8.1.1-1) (*MPO 2011*). Port of Ponce Railroad/Chemex Railroad is the only industrial railroad operating on the entire island and is located within Ponce, Puerto Rico. It consists of a small railroad yard and a railroad ferry terminal. About twice monthly, the railroad ferry transports tanker cars on a barge between Mobile, Alabama, and the Ponce rail terminal, delivering chemicals for Puerto Rico's pharmaceutical industry (*Railroads of Puerto Rico 2012*).

Ports

The Puerto Rico Ports Authority is a government-owned corporation charged with developing, operating, and overseeing all seaports and airports in Puerto Rico. The Authority is ascribed to the Department of Transportation and Public Works and is governed by a Board of Directors, whose members are appointed by the governor with the advice and consent of the U.S. Senate (*MPO 2013*).



Sources: Esri, TomTom 2014a; Esri, TomTom 2014b; NGA 2015

Figure 8.1.1-1: Major Roads, Ports, and Railroad Transportation in Puerto Rico

Major ports in Puerto Rico include:

- San Juan Port–The largest port in Puerto Rico. It consists of three ports, including a port in Old San Juan, which services cargo/freight and cruise ships; the Pan American Port Terminal in Isla Grande section mostly for cruise ships; and Puerto Nuevo, exclusively for freight/cargo ships. It is the main port of the island (*MPO 2011*).
- Port of Ponce–The second largest port in Puerto Rico used for both freight/cargo and cruise ships.
- Port of Mayagüez–The third largest port in Puerto Rico. It is mainly used for freight/cargo ships, but is also home to the Dominican Republic-Puerto Rico passenger ferry and used for cruise ships (*Egido 2008*).

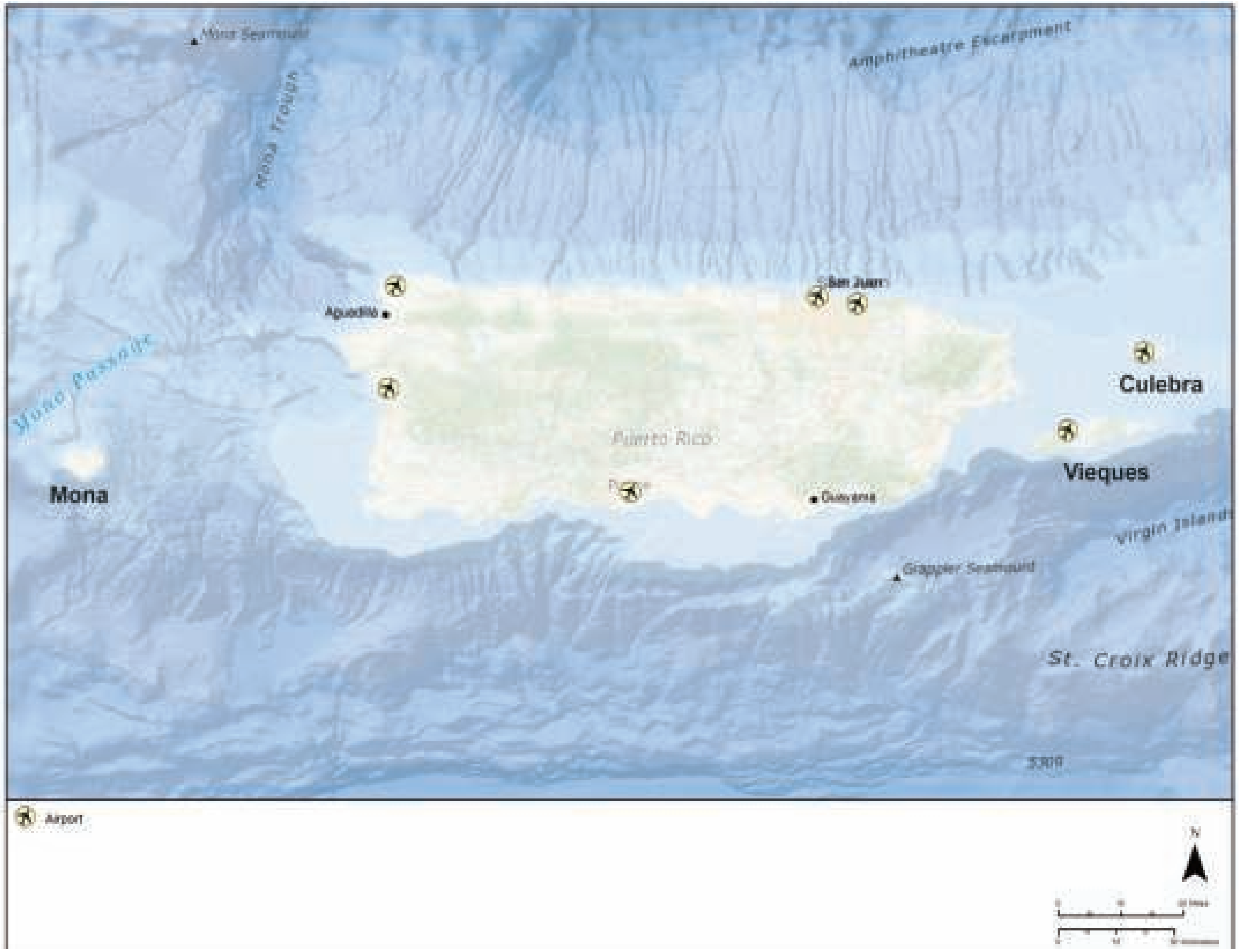
Minor ports in Puerto Rico include Guánica, Guayanilla, Guayama, Fajardo, Culebra, and Vieques. These minor ports are used for small freight/cargo ships, fishing vessels, and private boats/yachts. Figure 8.1.1-1 shows port locations throughout the territory.

Interisland Transport

Cataño Ferry is a daily ferry service that operates a route across San Juan Bay between Old San Juan and the municipality of Cataño. Additional ferries operate between Fajardo, Culebra, and Vieques; San Juan and Cataño; and Ponce and Caja de Muertos (Coffin Island) (*Islands of Puerto Rico.com 2015*).

Airports

There are seven airports in Puerto Rico (see Figure 8.1.1-2); of those, three are international (*MPO 2013*). The Luis Muñoz Marín International Airport is the primary airport in Puerto Rico, providing connections to the U.S., Spain, Latin America, and the Caribbean; it contains three concourses and two runways (*MPO 2011*). The Luis Muñoz Marín International Airport is also the location of the Muñiz Air National Guard Base, which serves as the military airport for the Puerto Rico Air National Guard (*Airways International, Inc. 2015*).



Source: National Atlas 2014

Figure 8.1.1-2: Airports in Puerto Rico

8.1.1.4. Public Safety Services

This section provides a description of baseline public safety telecommunications infrastructure conditions as they relate to police services, fire services, EMS, and hospitals in Puerto Rico.

The Puerto Rico Commission on Safety and Public Protection (the Commission) is the agency of the executive branch of the government of Puerto Rico that coordinates, manages, and oversees all the public safety agencies and related private organizations in Puerto Rico (*USDOJ 2011*). The Commission is composed of the Adjutant General, the Fire Chief, the Police Superintendent, and the Director of the State Agency for Emergency and Disaster Management, with one of the aforementioned officers presiding as the Commissioner of Safety and Public Protection.

Police Services

The Puerto Rico Police Department is the territory police of Puerto Rico. The Puerto Rico Police is also one of two investigative arms of many Puerto Rico municipal police forces, the other being the Puerto Rico Special Investigations Bureau of the Puerto Rico Department of Justice.

The Puerto Rico Police is organized into 13 regions within Puerto Rico, including Aguadilla, Aibonito, Arecibo, Bayamón, Caguas, Carolina, Fajardo, Guayama, Humacao, Mayagüez, Ponce, San Juan, and Utuado. Each region has a commanding officer and two sub-commanding officers, one for investigation and the other for field operations (*USDOJ 2011*).

In addition to police services, Puerto Rico relies heavily on the United States (U.S.) military for public protection. A Navy Operational Support Center is based in Puerto Rico (*Navy Recruiting Command 2015*). The Puerto Rico Air National Guard and the Puerto Rico Army National Guard are responsible for the protection of the people of Puerto Rico in the event of war or other natural or manmade disasters. The Puerto Rico Army National Guard operates 48 armories and is present in 30 communities within the territory (*U.S. Army National Guard 2015*). The Puerto Rico Air National Guard has three bases located in Carolina, Aguadilla, and Toa Baja, Puerto Rico (*U.S. Air National Guard 2015*).

The U.S. Coast Guard is responsible for maritime safety and security, protection of natural resources, homeland security, and national defense. The Coast Guard is also one of the primary units responsible for safety, emergency response, and enforcement in the sea. Sector San Juan of the U.S. Coast Guard serves all of Puerto Rico and the U.S. Virgin Islands (*USDHS USCG 2015*).

Fire Services

The Puerto Rico Firefighters Corps (the Corps), locally known as the Cuerpo de Bomberos de Puerto Rico, is a territory-wide fire department first established under the Puerto Rico Fire Services in 1942. The Corps consists of over 90 fire stations with just under 2,000 employees. According to the U.S. Fire Administration, the National Fire Department Census includes listings of seven departments in Puerto Rico, including the Puerto Rico Firefighters Corps in Guayanilla, Morovis, and San Juan, as well as other separate departments in Guaynabo and

Canovanas and two in Carolina (*U.S. Fire Administration 2016*). The departments listed in the census, however, include a federal government (U.S. Department of Defense) fire department as well as other local EMS and lifeguard and rescue entities. In addition, over the past decade, the U.S. Fish and Wildlife Service and the Puerto Rico Fire Department have worked together to improve wildland firefighter training in Puerto Rico and share resources to help suppress wildland fires. This has included, among other things, training sessions held to teach structural firefighters tactics for fighting wildland fires (*USFWS 2011*).

EMS and Hospital Services

The Puerto Rico Medical Emergency Corps is the agency of the executive branch of the government of Puerto Rico that responds to all medical emergencies within the jurisdiction of Puerto Rico. The agency is assigned to the Department of Health of Puerto Rico and is a component of the Puerto Rico Emergency Operations Center (*Puerto Rico Office of Management and Budget 2011*).

A total of 54 hospitals are located throughout Puerto Rico, providing 8,538 staffed beds within the hospital system (*American Hospital Directory 2015*). Most of the hospitals in Puerto Rico use air-medical transportation for transporting patients between islands and hospitals (*Island Airlines, LLC 2013*).

8.1.1.5. Communications

Over the years, numerous lives have been lost as a result of the lack of interoperability in public safety telecommunications in the United States. The Final Report of the Public Safety Wireless Advisory Committee identified three main issues in public safety communications: 1) congested radio frequencies; 2) the inability of public safety officials to communicate with each other due to incompatible equipment, multiple frequency bands and lack of standardization in repeater spacing and transmission formats; and 3) the lack of cutting edge communications technologies (*Public Safety Wireless Advisory Committee 1996*). Large-scale emergency situations like Hurricane Sandy in 2012 and the September 11, 2001, attacks further exposed vulnerabilities in the public safety communications systems, especially as they related to inadequate infrastructure. During Hurricane Sandy, resilient infrastructure to withstand weather related risks was not available, which led to devastating power outages, fuel shortages, and significant road and transit complications (*HSRTF 2013*). Likewise, based on the September 11 attacks the National Task Force on Interoperability concluded that more effective infrastructure capable of supporting interoperable radio communications could have resulted in the preservation of numerous lives (*NTFI 2005*). Additionally the National Task Force on Interoperability asserts that during major emergencies it is often extremely difficult for first responders to communicate across jurisdictions given the reliance on multiple separate and incompatible communications systems (*NTFI 2005*).

Puerto Rico has a complex geography and a fragmented landscape and is prone to natural catastrophes like hurricanes, which add an extra level of challenge in ensuring adequate communication systems are in place).

The following communication methods are used by various public safety services in Puerto Rico:

- *Federal Emergency Management Agency Integrated Public Alert and Warning System (IPAWS):* A national public alert warning system implemented by the Federal Emergency Management Agency, National Oceanic and Atmospheric Administration National Weather Service, Federal Communications Commission, and Department of Homeland Security Science and Technology Directorate in order to provide emergency alert information prior to, during and after emergencies and disasters (*FEMA 2015c*).
- *National Incident Management System:* Provides a template for departments, agencies and nongovernmental organizations so that they will have the capacity to properly protect against, recover from and mitigate the effects of largescale incidents (*FEMA 2015d*).
- *Puerto Rico Interoperable Communications Committee and the Puerto Rico Public Safety Broadband Network Committee:* Committees formed in order to renovate the territory's statewide interoperability plan. Puerto Rico uses the Public Safety Broadband Network Committee, the existing organizing structures under the Interoperable Communications Committee, and its regional structure under the Homeland Security Regional Boards as the primary vehicles for education and outreach to local jurisdiction (*NTIA 2013*).

According to the National Highway Traffic Safety Administration, "Puerto Rico lacks a real-time notification system to alert identified health care providers of a disaster event. The territory also lacks patient and victim tracking systems, a medical communication system with one layer of redundancy, and a real-time syndromic surveillance system" (*NHTSA 2009*).[2]

8.1.1.6. Other Utilities

Energy

The Puerto Rico Electric Power Authority (PREPA) is a government-owned electric power company responsible for electricity generation, power transmission, and power distribution in Puerto Rico (*USDOE 2003*). PREPA is the only entity authorized to conduct such business in Puerto Rico, effectively making it the primary authority in energy and power generation in the territory. The authority is managed by a board of directors appointed by the governor with the advice and consent of the U.S. Senate. Puerto Rico's per-capita electricity consumption is about two-fifths of the U.S. average *(EIA 2015*).

Approximately four-fifths of the energy used in Puerto Rico comes from petroleum. Petroleum products are imported and brought in primarily through the ports of San Juan, Guayanilla, Fajardo, and Ponce to Puerto Rico, as the island neither produces nor refines petroleum (*EIA 2015*). The largest consumers of petroleum products in the territory are the electric power

[2] In this context, notification refers to the ability of health care providers to be alerted in the event of a disaster. Redundancy refers to the duplication of equipment or processes to help maintain continuity of operations.

and transportation sectors. Puerto Rico's per capita petroleum consumption is about 70 percent of the U.S. average because of its dependence on residual fuel oil and diesel fuel for two-thirds of the islands' electricity. To reduce fuel costs and consumption, the island is considering substituting propane at its power generating plants (*EIA 2015*). Puerto Rico has enacted a Renewable Energy Portfolio Standard to supplement its electricity generation from renewable sources. This standard requires PREPA to get 12 percent of its electricity from renewable sources starting in 2015, scaling up 20 percent by 2035 (*EIA 2015*). Technologies like hydroelectric, solar photovoltaic, wind, geothermal, biomass including municipal solid waste, and ocean and tidal energy generation are some of the many technologies that meet this standard.

Puerto Rico does not produce natural gas and coal. Puerto Rico's per capita natural gas consumption is less than one-sixth of the U.S. average as natural gas is consumed only in electricity production. All natural gas is imported as liquefied natural gas mainly from Trinidad and Tobago. However, liquefied natural gas imports are increasing to support PREPA's plans to lower fuel costs and meet federal emissions standards. Coal is imported to Puerto Rico annually from Columbia to supply the island's coal-fired electricity generation plant, located at Guayama (*EIA 2015*).

Wastewater

The Puerto Rico Aqueduct and Sewer Authority (PRASA) owns and operates the island-wide public water and wastewater systems. Approximately 55 percent of the population receives service from the PRASA's wastewater system (*GDP 2015*). PRASA has 5,994 miles of wastewater pipelines and operates 52 wastewater treatment plants that treat 233 million gallons per day of sewage (*PRASA 2016*).

Water Supply

Over 97 percent of Puerto Rico's population is served by PRASA's water system (*GDP 2015*). The three main sources of freshwater in Puerto Rico are desalinated water, groundwater, and surface water; however, desalinated water typically makes up less than 1 percent of freshwater withdrawals. In 2005, 722 million gallons per day of freshwater were processed for offstream uses. Of the freshwater, 80 percent (approximately 578 million gallons per day) came from surface water sources and 20 percent (approximately 144 million gallons per day) came from groundwater sources. In 2005, an average of approximately 92 gallons of water per person per day was used for domestic purposes. Forty-five percent of water used for domestic purposes was consumed (*USGS 2009*).

Storm Water

In 2014, the U.S. Environemental Protection Agency (USEPA) filed a complaint alleging that storm water containing untreated waste was being discharged through highway and road drainage systems. The government of Puerto Rico entered into an agreement with the USEPA in December 2015 to upgrade its road and highway drainage and storm water systems at a cost of approximately $77 million (*Water Environment Federation 2016a*).

In addition, the Municipality of San Juan entered into an agreement with the USEPA in October 2015 to upgrade its storm water system and implement a storm water management plan (*Water Environment Federation 2016b*). San Juan has four combined sewer outfalls that have the potential to contain both storm water and untreated human and industrial waste; during heavy rains, this can result in raw sewage discharging into waterbodies (*USEPA 2013*). The municipality will spend approximately $180 million to make required improvements over a period of 14 years from the date of the agreement (*Water Environment Federation 2016b*).

8.1.2. Soils

8.1.2.1. Introduction

This section discusses the existing soil resources in Puerto Rico. Information is presented regarding soil features and characteristics that would be potentially sensitive to impacts from deployment and operation of the Proposed Action.

The Soil Science Society of America defines soil as:

> "(i) The unconsolidated mineral or organic material on the immediate surface of the Earth that serves as a natural medium for the growth of land plants.
>
> (ii) The unconsolidated mineral or organic matter on the surface of the Earth that has been subjected to and shows effects of genetic and environmental factors of: climate (including water and temperature effects), and macro- and microorganisms, conditioned by relief, acting on parent material over a period of time. A product-soil differs from the material from which it is derived in many physical, chemical, biological, and morphological properties and characteristics." *(NRCS 2015*)

Five primary factors account for soil development patterns. A combination of the following variables contributes to the soil type in a particular area (*Anderson et al. 2001*):

- *Parent Material:* The original geologic source material from which the soil was formed affects soil aspects, including color, texture, and ability to hold water.
- *Climate*: Chemical changes in parent material occur slowly in low temperatures. However, hot temperatures evaporate moisture, which also facilitates chemical reactions within soils. The highest degree of reaction within soils occurs in temperate, moist climates.
- *Topography*: Steeper slopes produce increased runoff, and, therefore, downslope movement of soils. Slope orientation also dictates the microclimate to which soils are exposed, because different slope faces receive more sunlight than others.

8.1.2.2. Specific Regulatory Considerations

Soil Erosion and Sedimentation Permits are required from the Environmental Quality Board in Puerto Rico for soil disturbance impacts of more than 0.22 acre (900 square meters). This permit is used to identify measures to avoid or reduce impacts to soil resources.[1] There are no other Puerto Rico-specific regulatory considerations that pertain to the Proposed Action outside of those discussed in Section 1.8, Overview of Relevant Federal Laws and Executive Orders, and Appendix C, *Environmental Laws and Regulations*.

8.1.2.3. Environmental Setting

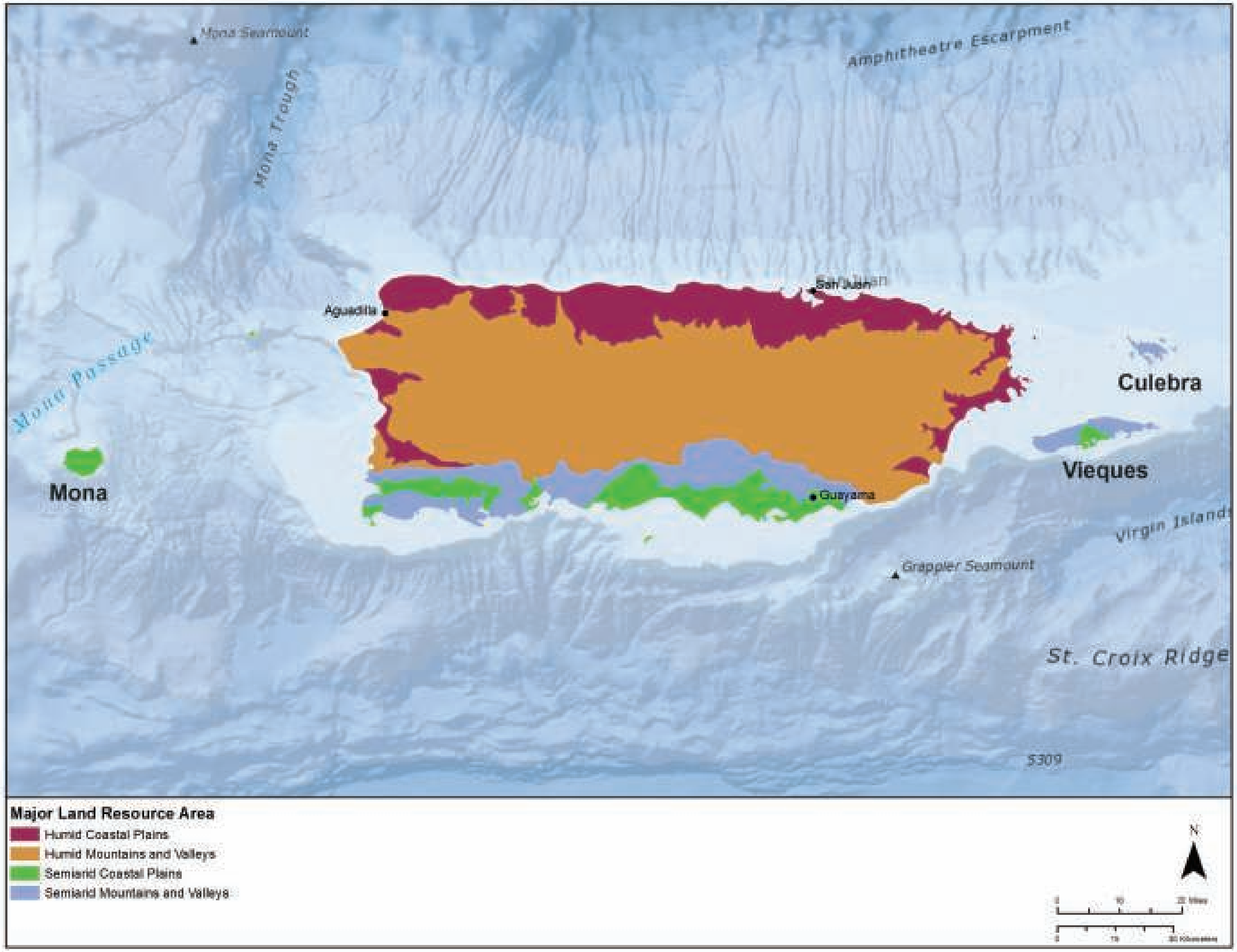
Soil formation occurs due to complex and multiple interactions among geologic material, climate, topography, biological processes (such as vegetation growth and interactions with other organisms), and time. The soil resources present in Puerto Rico were identified, evaluated, and described using information gathered from and characteristics as defined by the U.S. Department of Agriculture Natural Resources Conservation Service (NRCS) State Soil Geographic (STATSGO2) soil order and suborder information (*STATSGO2 Database 2015*) database, and the NRCS's Major Land Resources Areas (MLRAs) soil descriptions[2] (*NRCS 2006*). FirstNet used the STATSGO2 database to obtain soils information at the programmatic level to ensure consistency across all the states and territories. This regional information provides a sufficient level of detail for a programmatic analysis. Where appropriate, the best available soils data and information, including the use of the more detailed SSURGO database, will be used during subsequent site-specific assessments.

Puerto Rico is located in the Caribbean land resource region along with the U.S. Virgin Islands. Within this region in Puerto Rico, the four major land resource areas consist of the Humid Coastal Plains, Humid Mountains and Valleys, Semiarid Coastal Plains, and Semiarid Mountains and Valleys (see Figure 8.1.2-1).

---

[1] See Chapter 11, BMPs and Mitigation Measures, for specific information related to best management practices that would be implemented to reduce or avoid potential impacts to soil resources.

[2] The NRCS categorizes soil resources into land resource units based on significant geographic differences in soils, climate, water resources, or land use. These land resource units are typically coextensive with general soil map units at the territory level. Geographically associated land resource units are further grouped into major land resource areas, which are then grouped into land resource regions. These large areas are important for territory-wide agricultural planning as well as interstate, regional, and national planning.



Source: NRCS 2006

Figure 8.1.2-1: Major Land Resource Areas of Puerto Rico

Humid Coastal Plains

The Humid Coastal Plains major land resource area is primarily located on the northern portion of Puerto Rico, but small areas also exist on the east and west coasts. The physiography of this area is divided into two distinct areas. One area, located along the coast, is characterized by flat alluvial plains and terraces. The other area includes irregular features of karst limestone inland (see Section 8.1.3, Geology, for more information on karst). Dominant soils in this major land resource area consist of clays found near coastal plains, along rivers and lagoon-like depressions, and in areas of limestone karst (*NRCS 2006*).

Humid Mountains and Valleys

The Humid Mountains and Valleys major land resource area encompasses the majority of central Puerto Rico and is its largest major land resource area. The physiography includes three different mountain ranges and is characterized as having very steep slopes and narrow valleys. Given its elevation and central location on the island, the headwaters of almost all of the rivers and streams are located in this major land resource area. Most of the soils here are clayey or loamy (*NRCS 2006*).

Semiarid Coastal Plains

The Semiarid Coastal Plains reside near portions of the southern coast of Puerto Rico. Near the coast, this area gently slopes up from the Caribbean Sea; further inland, the slopes become steeper. Dominant soils in this major land resource area are clayey or loamy (*NRCS 2006*).

Semiarid Mountains and Valleys

The Semiarid Mountains and Valleys major land resource area also resides near portions of the southern coast of Puerto Rico. This area consists of the southern slopes that make up the central mountain chain. Slopes here range from moderately steep to nearly vertical. Dominant soils in this major land resource area are underlain by volcanic rocks and are generally shallow or moderately deep, well drained, and clayey (*NRCS 2006*).

8.1.2.4. Soil Suborder Characteristics

The STATSGO2 soil database identified 20 soil suborders in Puerto Rico. Table 8.1.2-1 provides a summary of the major physical-chemical characteristics of the various soils in Puerto Rico, and Figure 8.1.2-2 (located after the table) depicts the distribution of the suborders. A summary of the major soil characteristics relevant to the types of activities expected to be associated with the Proposed Action is presented in the table below.

Table 8.1.2-1: General Characteristics of Soil Suborders Found in Puerto Rico

Soil Order	Soil Suborder	Ecological Site Description	Soil Texture	Slope (%)	Runoff Potential	Erosion Potential	Drainage Class	Permeability[a]	Hydric Soil[b]	Compaction and Rutting Potential
Alfisols	Udalfs	Udalfs have a humid climate moisture regime and are formed under forested conditions.	Clay	2 - 60	Low to high	Slight to severe	Well drained	Slow	No	Moderate
	Ustalfs	Ustalfs are found in semiarid and subhumid climates and are formed under forested conditions.	Gravelly clay loam	5 - 20	Low to moderate	Slight to moderate	Well drained	Moderate	No	Low
Entisols	Aquents	Aquents are widely distributed, with some forming in sandy deposits, and most forming in recent sediments; water table at or near the surface for much of the year; supports vegetation that tolerates either permanent or periodic wetness, and are mostly used for pasture, cropland, forest, or wildlife habitat.	Sandy, but often variable	0 - 2	Low	Slight	Poorly drained	Moderate	Yes	Moderate to high
	Fluvents	Fluvents are commonly found on floodplains; sugarcane, cultivated crops, and improved pasture cover some areas; soils generally have good potential for farming.	Sandy loam	0 - 2	Low	Slight	Excessively drained	Moderate	No	Moderate to high
	Psamments	Psamments are very sandy, young soils; commonly wet; subject to blowing and drifting; mostly used as rangeland, pasture, or wildlife habitat.	Sandy loam	0 - 3	Low	Moderate to high	Excessively drained	Moderate	No	Moderate to high

Soil Order	Soil Suborder	Ecological Site Description	Soil Texture	Slope (%)	Runoff Potential	Erosion Potential	Drainage Class	Permeability[a]	Hydric Soil[b]	Compaction and Rutting Potential
Histosols	Saprists	Sprists consist of well decomposed organic materials and may be classified as muck; many support natural vegetation and are used as woodland, rangeland, or wildlife habitat; some areas, particularly those with a warmer temperature regime, have been cleared, drained, and used as cropland.	Muck	0 - 2	Low	Slight	Very poorly drained	Slow to moderate	Yes	Moderate to high
Inceptisols	Aquepts	Aquepts have poor or very poor natural drainage; if these soils have not been artificially drained, ground water is at or near the soil surface; primarily used for pasture, cropland, forest, or wildlife habitat; likely formed under forest vegetation.	Silty clay	0 - 2	Low to moderate	Slight	Poorly drained	Slow	Some[c]	Moderate to high
	Udepts	Udepts often on steep slopes and are mainly freely drained; most areas currently support or formerly supported forest vegetation; some also support shrub or grass vegetation, and in addition to being used as forest, some have been cleared and are used as cropland or pasture.	Clay loam; gravelly sandy loam; weathered bedrock	12 - 60	Moderate to high	Moderate to severe	Well drained	Moderate to slow	No	Moderate

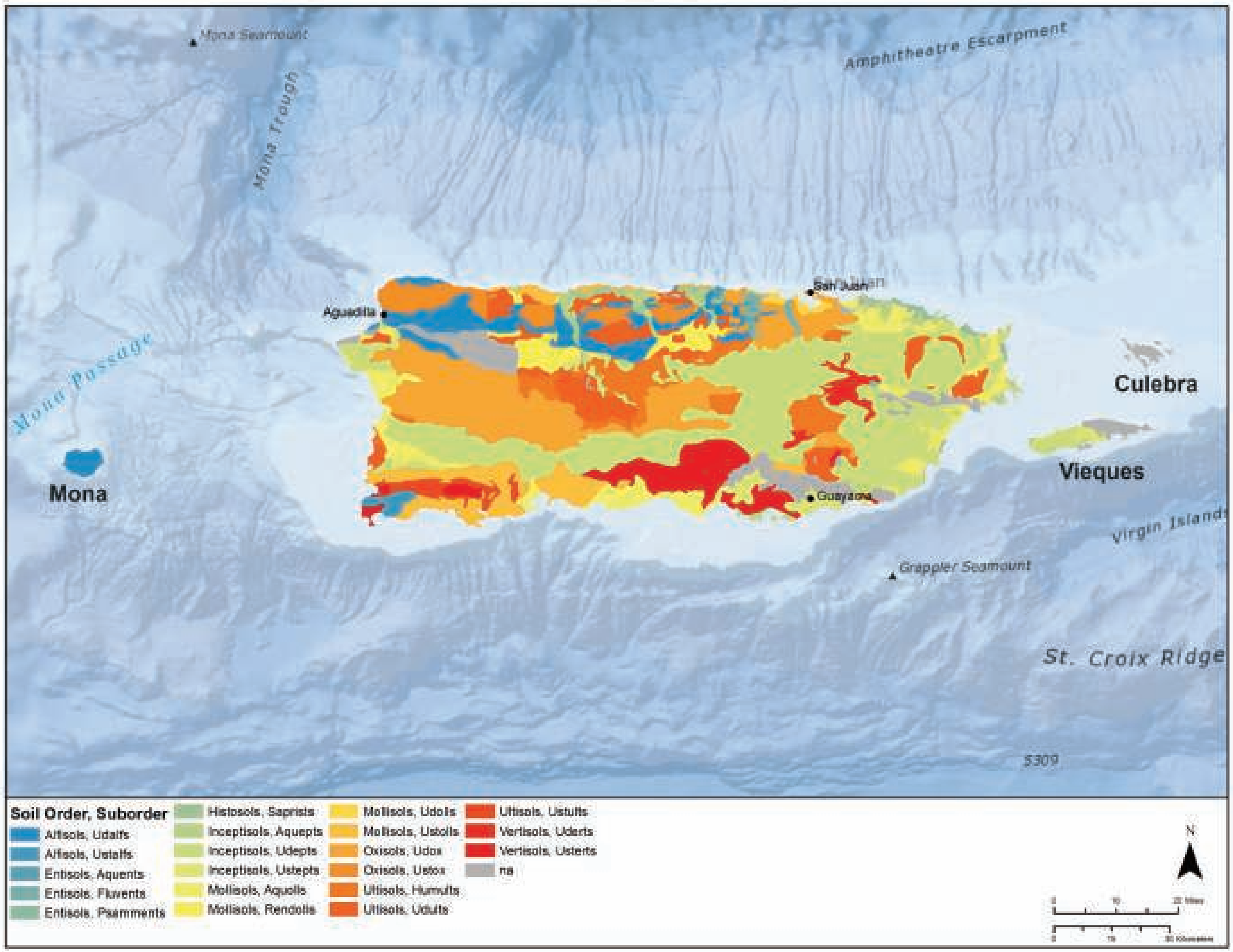
Soil Order	Soil Suborder	Ecological Site Description	Soil Texture	Slope (%)	Runoff Potential	Erosion Potential	Drainage Class	Permeability[a]	Hydric Soil[b]	Compaction and Rutting Potential
Inceptisols	Ustepts	Ustepts are found in semiarid and subhumid climates, on young geomorphic surfaces or resistant parent material (as with other Inceptisols).	Clay loam	0 - 2	Low to moderate	Slight	Moderately well drained	Slow	No	Moderate
Mollisols	Aquolls	Grassland soils with a thick surface horizon, often very fertile due to organic materials; Aquolls have a water table at or near the surface for much of the year; commonly wet.	Clay; silty clay	0 - 2	Low to moderate	Slight	Poorly drained	Slow to moderate	Some[c]	Moderate to high
	Rendolls	Grassland soils with a thick surface horizon, often very fertile due to organic materials; Rendolls are formed over calcareous parent material (such as limestone rock).	Clay; weathered bedrock	5 - 60	Moderate to high	Moderate to severe	Well drained	Slow	No	Moderate
	Udolls	Grassland soils with a thick surface horizon, often very fertile due to organic materials; Udolls are found in humid climates.	Sand	0 - 2	Low	Slight	Excessively drained	Moderate to rapid	No	Moderate
	Ustolls	Grassland soils with a thick surface horizon, often very fertile due to organic materials; Ustolls are found in semiarid and subhumid climates.	Silty/ gravelly loam and clay loams	2 - 60	Low to high	Moderate to severe	Well drained	Slow to moderate	No	Moderate
Oxisols	Udox	Highly weathered soils rich in iron and aluminum; low fertility without fertilizers; Udox are found in humid climates.	Clay; silty clay loam	5 - 60	Moderate to high	Moderate to severe	Moderately well drained to well drained	Slow to moderate	No	Low to moderate

Soil Order	Soil Suborder	Ecological Site Description	Soil Texture	Slope (%)	Runoff Potential	Erosion Potential	Drainage Class	Permeability[a]	Hydric Soil[b]	Compaction and Rutting Potential
Oxisols	Ustox	Highly weathered soils rich in iron and aluminum; low fertility without fertilizers; Ustox are found in semiarid and subhumid climates.	Clay; weathered bedrock	2 - 12	Moderate	Moderate	Well drained	Slow	No	Low to moderate
Ultisols	Humults	Forest soils with low fertility with subsoil clay accumulation; Humults are well-drained and have high organic matter content.	Silty clay/silty clay loam	2 - 60	Low to high	Slight to severe	Well drained	Moderate	No	Low to moderate
	Udults	Forest soils with low fertility with subsoil clay accumulation; Udults are more or less freely drained and are found in humid climates; most soils currently support or formerly supported mixed forest vegetation.	Clay; silty clay; sandy loam, clay loam	2 - 40	Low to high	Slight to severe	Moderately well drained to well drained	Slow to Moderate	No	Moderate to high
	Ustults	Forest soils with low fertility with subsoil clay accumulation; Ustults are found in semiarid and subhumid climates.	Loam	2 - 4	Low	Slight	Moderately well drained	Moderate	No	Moderate

Soil Order	Soil Suborder	Ecological Site Description	Soil Texture	Slope (%)	Runoff Potential	Erosion Potential	Drainage Class	Permeability[a]	Hydric Soil[b]	Compaction and Rutting Potential
Vertisols	Uderts	Clayey soils with high shrink/swell capacity with changes in moisture; Uderts are found in humid climates.	Clay	5 - 12	Low to moderate	Slight to moderate	Somewhat poorly drained	Slow to moderate	No	Moderate
	Usterts	Clayey soils with high shrink/swell capacity with changes in moisture; Usterts are in semiarid and subhumid climates.	Clay; silty clay loam, gravelly loam	0 - 12	Low to moderate	Slight to moderate	Somewhat poorly drained to well drained	Slow to moderate	No	Low to moderate

Sources: NRCS 2006; STATSGO2 Database 2015

[a] Permeability refers to the ability and pace of the soil to allow water to pass through it.
[b] Hydric soils are explained in the text above.
[c] Hydric inclusions occur in this unit depending on its location in the landscape.



Source: STATSGO2 Database 2015

Figure 8.1.2-2: Soil Suborder Map of Puerto Rico

Slope and Runoff and Erosion Potential

Slopes on Puerto Rico range from 0 to 60 percent (flat to steep). The characteristic clayey soils along with steep slopes tend to result in a moderate to high potential for runoff and erosion although some soil suborders also have a low or slight potential, as indicated in Table 8.1.2-1, depending on soil conditions and or specific soil properties. Generally, runoff and erosion diminish soil fertility as the topsoil is eroded way; this often leads to increased sedimentation in nearby surface waterbodies and can be exacerbated by ground disturbance activities. According to NRCS data, approximately 175,000 acres of prime farmland[3] (less than 8 percent of the total land area) exists on Puerto Rico. In addition, areas with very steep slopes with high potential for runoff and erosion are not well suited as construction locations. As explained in Section 8.1.2.3, Environmental Setting, three of the four major land resource areas in Puerto Rico are characterized as has having areas with steep slopes.

Drainage Class and Permeability

In Puerto Rico, the Aquents, Saprists, Aquepts, and Aquolls soil suborders are characterized as being poorly drained or very poorly drained. These soil suborders are found in areas where the water table is at or near the surface, or where environmental conditions have otherwise created slow drainage conditions. The majority of the remaining soil orders found on Puerto Rico are characterized as excessively drained or well drained. Permeability ranges from slow to rapid (see Table 8.1.2-1).

Hydric Soils

Hydric soils are formed under wet conditions, such as in low-lying areas prone to flooding or ponding, or areas with poorly drained soil types. In order for hydric soils to develop, these areas must be wet long enough during the growing season to develop anaerobic conditions that support the growth of water-tolerant vegetation, such as the vegetation found in certain wetland environments. Hydric soils or inclusions in soils can occur in the Aquents, Saprists, Aquepts, and Aquolls suborders depending on location in the landscape.

Compaction and Rutting Potential

Compaction and rutting[4] potential for soils found on Puerto Rico is generally moderate given the soil textures and drainage classes of the soils present. Of the soils present on Puerto Rico, the Aquents, Saprists, Aquepts, and Aquolls suborders likely have the greatest potential for compaction and rutting because these soil types are subject to flooding or are poorly drained. Wet soils tend to have a lower resistance to compaction and rutting than dry soils. Other soil suborders with a high potential for compaction and rutting include Fluvents and Psamments since they are found on floodplains and commonly wet.

[3] Prime farmland is land that possesses the required characteristics for producing food, feed, fiber, and oilseed crops.
[4] A soil rut is a sunken track or groove made by vehicle or equipment activity.

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8.1.3. Geology

8.1.3.1. Introduction

This section discusses the geologic resources and hazards in Puerto Rico. Information is regarding geologic features and characteristics that would be potentially sensitive to impacts from deployment and operation of the Proposed Action, as well as geologic hazards that could potentially affect the Proposed Action.

The U.S. Geological Survey (USGS) is the primary government organization responsible for the nation's geological resources. The USGS defines geology as an interdisciplinary science with a focus on the following aspects of earth sciences: geologic hazards and disasters, climate variability and change, energy and mineral resources, ecosystem and human health, and groundwater availability. Several of these elements are discussed in other sections of this Final Programmatic Environmental Impact Statement, including climate change (Section 8.1.14, Climate Change), biological resources (Section 8.1.6, Biological Resources), human health (Section 8.1.15, Human Health and Safety), and groundwater (Section 8.1.4, Water Resources).

8.1.3.2. Specific Regulatory Considerations

There are no Puerto Rico-specific regulatory considerations that pertain to geologic resources outside of those discussed in Section 1.8, Overview of Relevant Federal Laws and Executive Orders, and Appendix C, *Environmental Laws and Regulations*.

8.1.3.3. Environmental Setting

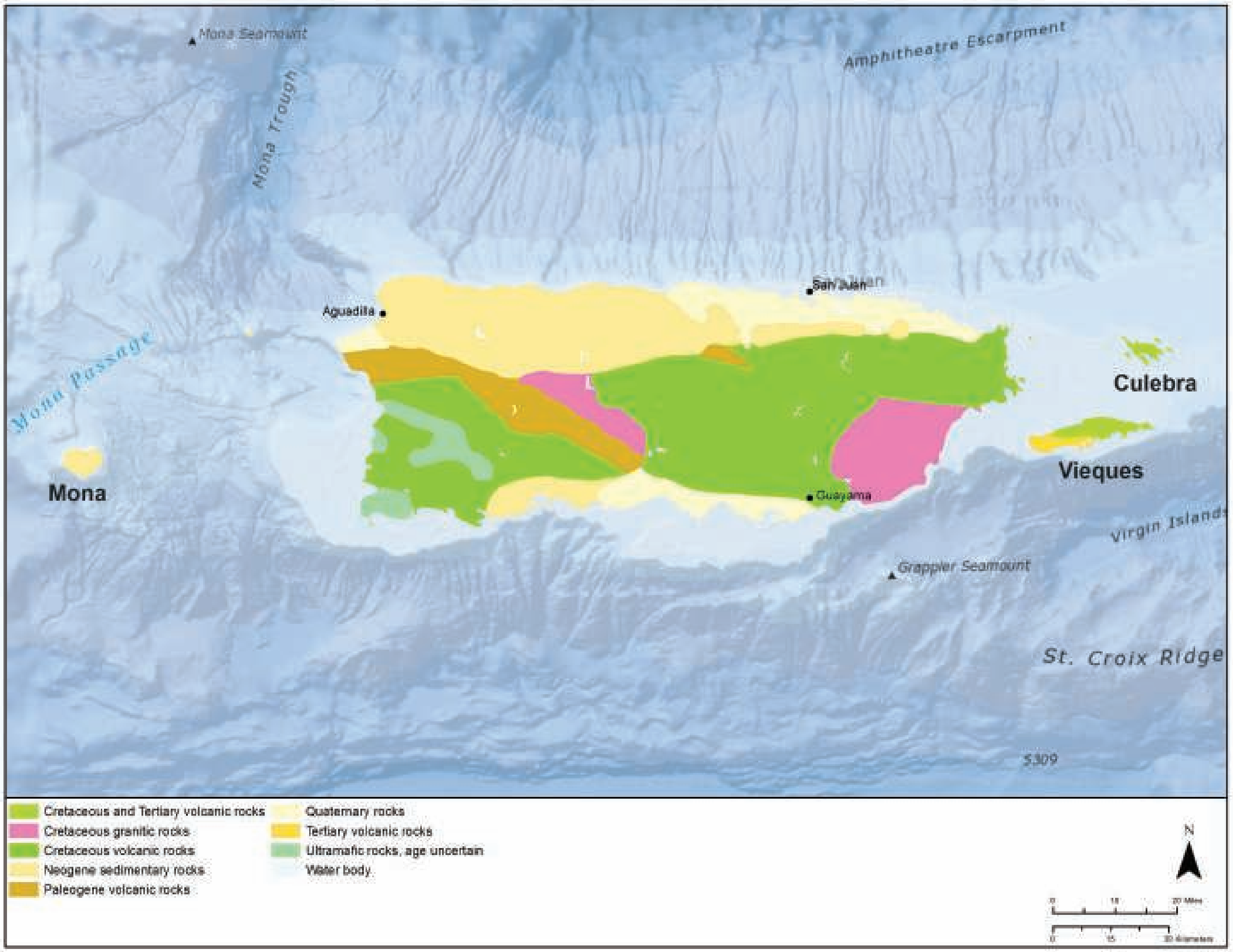
General Geologic Resources

Puerto Rico is located near the North American Plate and Caribbean Plate boundary (*USGS 2014*).[1] Major geologic units of Puerto Rico include older volcanic and plutonic rocks[2] that underlie younger limestone and other sedimentary rocks.[3] Figure 8.1.3-1 displays the geologic periods (or ages) and the typical rock types of Puerto Rico.

[1] The North American and Caribbean Plates are tectonic plates. The North American Plate underlies North America, Greenland, and surrounding areas as well as a portion of the Atlantic Ocean and the Gulf of Mexico. The Caribbean Plate underlies the Caribbean Sea and portions of Central America. Tectonic plates are the solid pieces of rock (or earth) that collide, move apart, or slide past each other over geologic time. See Section 9.1.3, Geology, for a description of the geologic setting in the U.S. Virgin Islands.

[2] Plutonic rocks are formed from cooling magma below the Earth's surface.

[3] Sedimentary rocks are formed by the deposition of material at the Earth's surface and within bodies of water.



Source: USGS 2005

Figure 8.1.3-1: Geologic Periods and General Rock Types of Puerto Rico

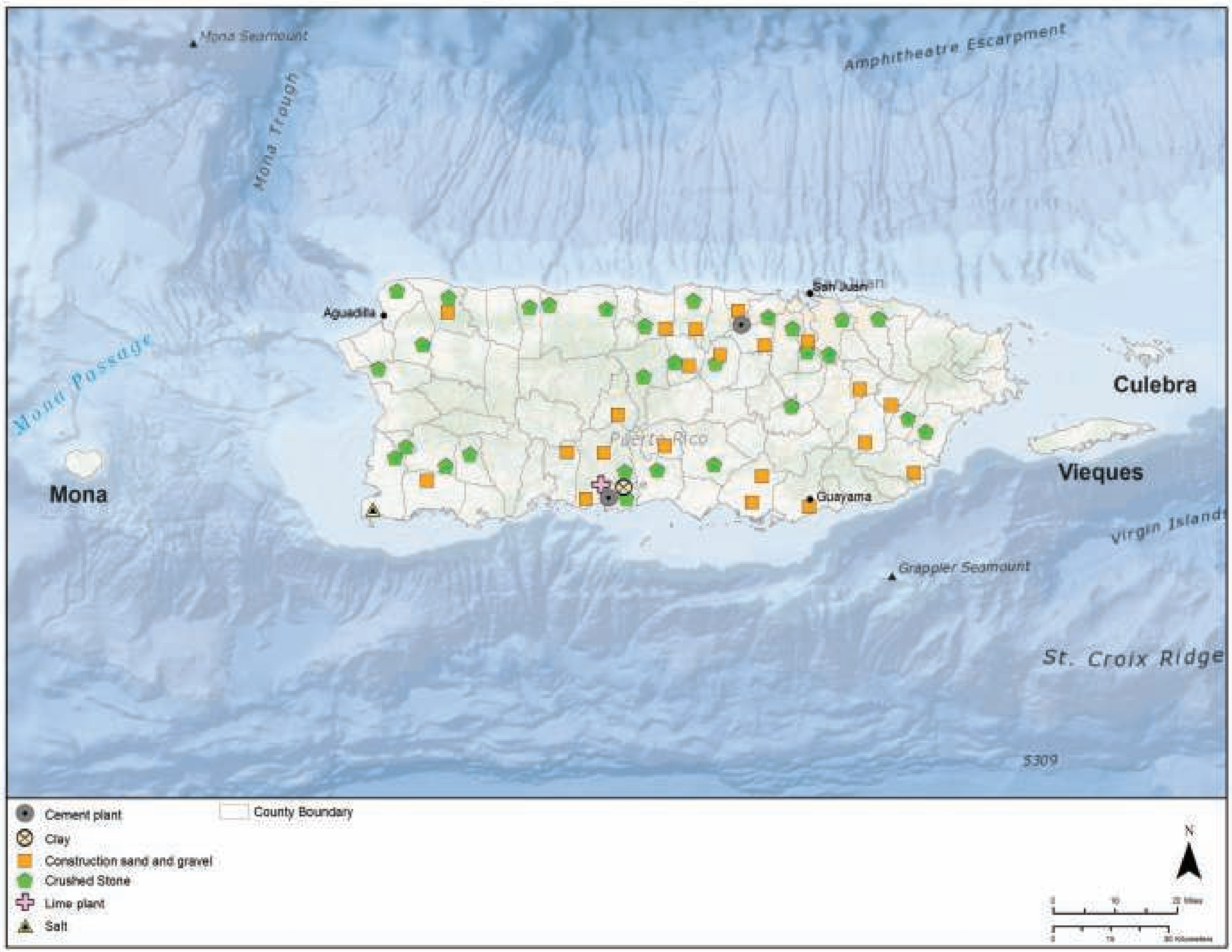
As described in Section 8.1.2, Soils, the major land resources areas of Puerto Rico include the Humid Coastal Plains, Humid Mountains and Valleys, Semiarid Coastal Plains, and Semiarid Mountains and Valleys (*NRCS 2006*).[4] The general topography and physiographic[5] characteristics of Puerto Rico include rugged mountains within the higher interior regions of the island surrounded by low-lying coastal plains and valleys (*Murphy et al. Undated*). The mountain ranges are primarily prevalent in the southern two-thirds of Puerto Rico and are generally oriented in the east-west direction (*Murphy et al. Undated*).

Mineral and Fossil Fuel Resources

Mineral production in Puerto Rico consists of crushed stone, clays, salt, and lime; lime and clay are used to produce portland cement[6] (*USGS 2015a*). Among the commodities reported to USGS, portland cement is the leading commodity by value in Puerto Rico, although approximately 8,300,400 short tons[7] of crushed stone are produced compared to about 853,200 short tons of portland cement (*USGS 2015a*). Following portland cement, crushed stone, lime, salt, and clays were the next largest commodities by value in 2011 with a total combined production value of $83,000,000 (*USGS 2015a*). Valuable minerals like copper, quartz, nickel, cobalt, manganese, and iron have been found in small deposits in Puerto Rico, although production quantities and values have not been recently reported to USGS (*USGS 1973; USGS 2015a*). Figure 8.1.3-2 displays the primary producing areas of the mineral resources in Puerto Rico.

Puerto Rico does not produce or refine petroleum, and must therefore import the island's entire usage to one of four main ports: San Juan, Guayanilla, Fajardo, and Ponce *(EIA 2016)*. Furthermore, Puerto Rico does not produce natural gas or coal. All of the natural gas used on the islands is imported as liquefied natural gas to a terminal and regasification facility in Guayanilla Bay *(EIA 2016)*. Puerto Rico has one coal-fired electricity generating plant, which uses approximately 1.6 million tons of coal imported annually from Colombia *(EIA 2016)*. For additional information related to energy sources and consumption, see Section 8.1.1, Infrastructure.

[4] Section 8.1.2, Soils, provides an explanation of the topography and physiographic characteristics and corresponding soil characteristics in Puerto Rico as they relate to the territory's land resource areas.
[5] Physiography refers to the description of the Earth's landforms and surface features.
[6] Portland cement is made from limestone and clay that turns to a paste and hardens with water.
[7] One short ton is equal to 2,000 pounds.



Source: USGS 2015a

Figure 8.1.3-2: Primary Mineral Production Areas in Puerto Rico

Paleontological Resources[8]

Numerous fossils and artifacts have been discovered on Puerto Rico, including fossils of extinct species. The San Sebastian formation, which is exposed at the surface in the northeast and north-central portions of Puerto Rico, contains numerous plant and animal fossils and is known for well-preserved mollusk shells (*Monroe 1980*). In addition, the Aguada Limestone formation in northwestern Puerto Rico also contains fossil beds, including preserved oysters (*Monroe 1968*). Field studies and associated analyses in the Lajas Valley of southwest Puerto Rico have yielded 23 different types of foram fossils,[9] as well as fish teeth, crustacean pincers, and other mollusks (*Gordon 1961*).

8.1.3.4. Geologic Hazards

Geologic hazards exist in many areas in Puerto Rico, including seismic activity, landslides, and land subsidence.

Seismic and Volcanic Activity

As mentioned above, Puerto Rico is located near the North American and Caribbean Plate boundary, and the movement and friction along the plate boundary and other associated fault systems is primarily responsible for earthquake activity (*USGS 2001*). Table 8.1.3-1 lists large earthquakes that have been recorded in the region of Puerto Rico. Figure 8.1.3-3 is a graphical representation of the seismic hazard risks in Puerto Rico.[10] The figure indicates that there is a moderate seismic hazard risk for the majority of the territory. Information related to real-time, historical, and significant earthquakes can be obtained via the USGS Earthquake Hazards Program website (*USGS 2015b*).

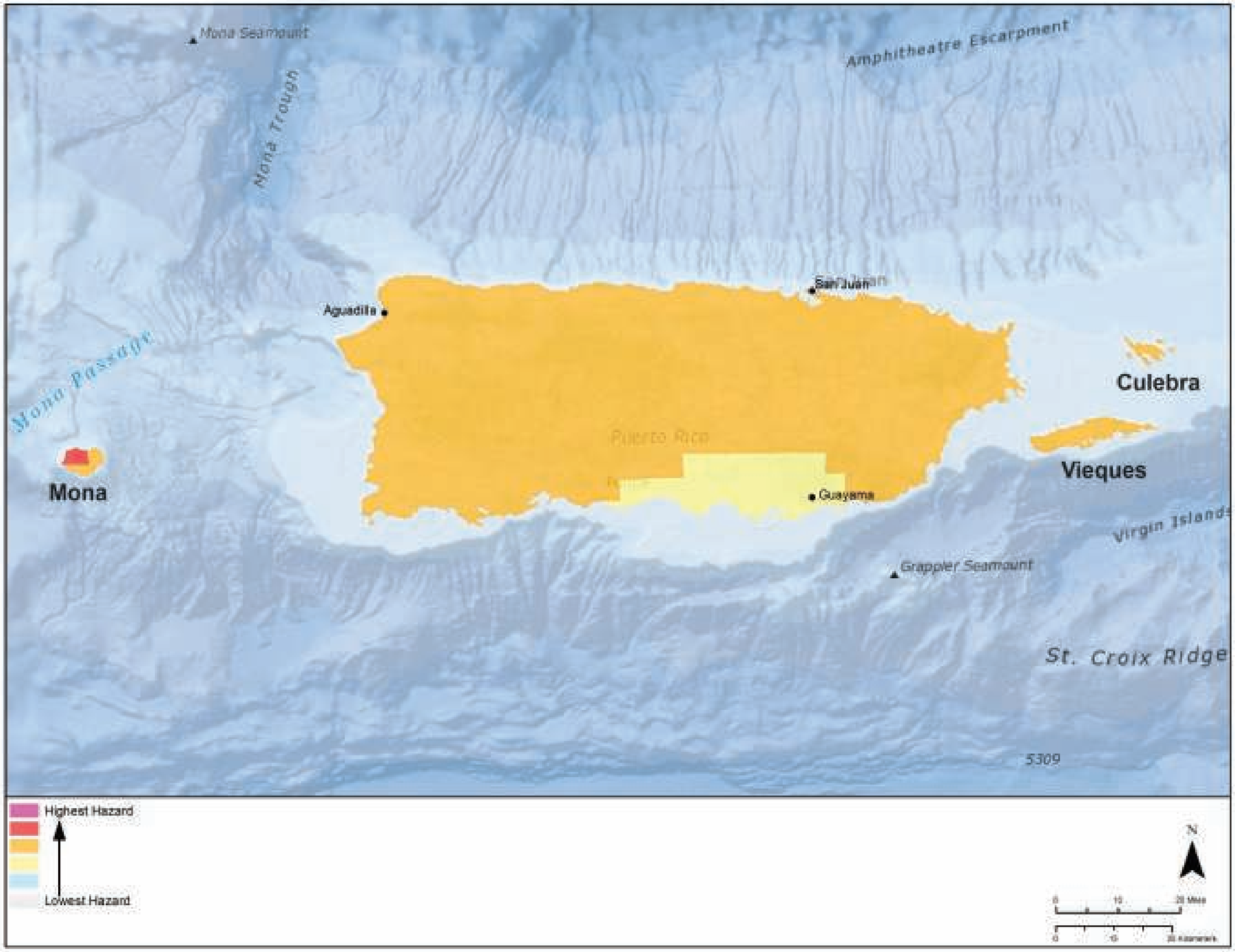
Table 8.1.3-1: Large Earthquakes Recorded Near Puerto Rico and the U.S. Virgin Islands

Location	Year	Magnitude[a]
Hispaniola	1953	6.9
Mona Canyon[b]	1946	7.5
Hispaniola	1946	8.1
Northwest of Puerto Rico	1943	7.5
Mona Canyon	1918	7.5
Anegada Trough	1867	7.5
Puerto Rico Trench	1787	8.1

Sources: USGS 2003; 2014

[a] Earthquakes with magnitudes of 3 or less are generally not felt. Magnitudes greater than 6 can cause widespread damage (*USGS 2012*).
[b] Between 1946 and 1953 four major aftershocks occurred with magnitudes of 7.6, 7.0, 7.3, and 7.1.

[8] Paleontological resources, or fossils, are the physical remains of plants and animals that have mineralized into or left impressions in solid rock or sediment.
[9] Forams (Foraminifera) are single-celled organisms with shells.
[10] Data from USGS were mapped showing the levels of horizontal ground shaking that have a 10 percent probability of exceedance in 50 years. This map was then simplified and scaled to show the areas ranging from high to low hazard potential.



Sources: USGS 2003; USGS 2014

Figure 8.1.3-3: General Seismic Hazard Map of Puerto Rico

Earthquakes can lead to abrupt disturbances of the ocean floor and ocean water that can cause tsunamis. Tsunamis are large ocean waves that form as a result of water displacement (*USGS 1997*). The source of a tsunami in Puerto Rico can originate from anywhere in the Gulf of Mexico, Caribbean Sea, the Atlantic Ocean,[11] or locally as a result of earthquakes on or near Puerto Rico. The 1918 earthquake referenced in Table 8.1.3-1 above created a tsunami that was responsible for the loss of 91 lives (*USGS 2001*).

Although the landmass of Puerto Rico started forming via volcanic activity about 190 million years ago (hence the presence of volcanic rocks as described above and shown in Figure 8.1.3-1), it is now an extinct volcanic island; there are no active volcanoes in Puerto Rico today (*NOAA 2015*).

Landslides

The term "landslide" refers to processes that lead to the downhill movement of earth materials due to gravity and other forces (*USGS 2004*). In Puerto Rico, excessive rainfall and seismic activity can trigger landslides, especially near areas that have steep slopes with loose or unconsolidated material. USGS conducted a study in the municipality of Ponce and determined that, given the local conditions, 34 percent of the land area in the municipality has a high susceptibility to rain-fall triggered landslides, and 24 percent of the area has moderate susceptibility (*Larsen et al. 2004*). In October 1985, a tropical storm and associated heavy rainfall triggered a landslide in northeast Puerto Rico that destroyed 120 houses and resulted in the loss of 129 lives (*NOAA Undated*).

Land Subsidence

Land subsidence is the downward settling or sudden sinking of the Earth's surface (*USGS 2013b*). The main causes of land subsidence may include groundwater level declines, drainage of organic soils, underground mining, excessive wetting of soils, natural compaction, sinkholes, and thawing permafrost (*USGS 2013b*). As is the case with karst topography,[12] land subsidence can also occur in areas with an abundance of underlying soluble rocks and minerals, such as limestone, gypsum, or salt, which have the potential to dissolve in water and wash out from the area (*USGS 2013b*). Limestone rocks at or near the land surface are primarily located in Puerto Rico near the northwest and north-central portions of the main island, and these areas are characterized as having abundant and very large sinkholes (*Weary and Doctor 2014*). The landmass of Isla de Mona, the large Puerto Rican island west of the main island, consists almost entirely of karst topography (*Weary and Doctor 2014*). Smaller areas of limestone rocks occur in the southeast and south central areas of Puerto Rico (*Weary and Doctor 2014*).

[11] Reports indicate that two separate earthquakes in the mid-1700s originating near Lisbon, Portugal (across the Atlantic Ocean) resulted in tsunamis in the Caribbean region (*USGS 2013a*).
[12] Karst is a terrain with distinctive landforms and hydrology created from soluble rock dissolution and characterized by springs, caves, sinkholes, and unique hydrogeology (*USGS Undated*).

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8.1.4. Water Resources

8.1.4.1. Introduction

This section discusses water resources in Puerto Rico, including surface water, floodplains, nearshore marine waters, and groundwater. Information is presented regarding features and characteristics of these waters that would be potentially sensitive to impacts from deployment and operation of the Proposed Action. Water resources are defined as all surface water bodies and groundwater systems including streams, rivers, lakes, canals, ditches, estuarine waters, floodplains, aquifers, and other aquatic habitats (wetlands are discussed separately in Section 8.1.5, Wetlands). These resources can be grouped into watersheds, areas of land whose flowing water resources (including runoff from rainfall) drain to a common outlet such as a river or ocean. The value and use of water resources are influenced by the quantity and quality of water available for use and the demand for available water. Water resources are used for drinking, irrigation, industry, recreation, and as habitat for wildlife. Some water resources that are particularly pristine, sensitive, or of great economic value enjoy special protections under federal and state/territory laws. An adequate supply of water is essential for human health, economic wellbeing, and the maintenance of natural infrastructure and ecological services (*USGS 2014*).

8.1.4.2. Specific Regulatory Considerations

Water quality is federally regulated pursuant to the Clean Water Act (CWA) (see Section 1.8.7, Clean Water Act), which is administered by the Puerto Rico Environmental Quality Board.

The National Flood Insurance Program (NFIP) is a federal program managed by the Federal Emergency Management Administration (FEMA) that allows property owners in participating communities to purchase flood insurance, with rates established through the National Flood Insurance Rate Maps.[1] In Puerto Rico, the Puerto Rico Planning Board is designated as the State Coordinating Agency responsible for administering the program. Implemented regulations include the Floodplain/Wetlands Environmental Review Requirements (*10 CFR § 1022.12*) and *Executive Orders 11988* and *13960* (see Section 1.8.10, Executive Order 11988 [as Amended by EO 13690] – Floodplain Management).

Puerto Rico implements the Coastal Zone Management Act (see Section 1.8.8) through the Puerto Rico Coastal Management Program, which was approved by the National Oceanic and Atmospheric Administration in 1978 and comprises a network of state agencies led by the Department of Environmental Resources. The program encompasses 40 statutes. The coastal zone in Puerto Rico extends 1,000 meters inland, but further inland in areas with important coastal resources.

[1] https://msc.fema.gov/portal

The Wild and Scenic Rivers Act (*Pub. L. No. 90-542; 16 USC § 1271 et seq.*) established the National Wild and Scenic River System and prescribed methods and standards through which rivers can be added to the system. Rivers protected under this act are generally free of impoundments, are inaccessible except by trail, and with watersheds or shorelines that are primitive and that have and unpolluted waters. Some protected rivers may be accessible by roads; however, they maintain many of the primitive and unpolluted qualities of the inaccessible rivers. On protected rivers, federal funding for actions such as construction of dams or other instream activities that would harm the river's free-flowing condition, water quality, or outstanding resource values are prohibited (*Pub. L. No. 90-542; 16 USC § 1271 et seq.*).

8.1.4.3. Environmental Setting

This section describes surface water, floodplain, nearshore marine, and groundwater characteristics in Puerto Rico. Water resources are discussed for Puerto Rico's largest island of Puerto Rico. Water resources are scarce and undeveloped on the remaining smaller islands; however, information on the larger of the smaller islands is provided where it was available.

Inland Surface Water Characteristics

Surface waters include rivers, streams, lakes, and reservoirs. The amount of water in any surface water system is dependent upon quantity and timing of precipitation, storage in the watershed, soil permeability, climate and evaporation rates, and watershed land cover. The primary inland surface water features in Puerto Rico are rivers and streams, with which total approximately 5,052.8 miles. Puerto Rico does not have natural lakes; impoundments form a total of 19 reservoirs that are used for hydroelectric power, irrigation, water supply, and recreation (*PREQB 2014*). The total surface waters in Puerto Rico are provided in Table 8.1.4-1.

Table 8.1.4-1: Total Surface Waters for Puerto Rico

Waters	Size	Units
Rivers and Streams	5,052.8	miles
Reservoirs	7,323	acres
Estuaries (excluding San Juan Bay)	3,430.3	acres
Sand Juan Bay	2,453.8	acres
Coastal Waters	546.63	miles

Source: PREQB 2014

Streams in Puerto Rico generally are small and have steep gradients, and many flow only immediately after periods of rainfall. Some streams, however, receive water from aquifers and have perennial flow (*Oki et al. 1999*). Perennial streams are those which normally contain water year-round, in all or part of their course, under normal precipitation conditions. Intermittent streams are normally dry during part of the year.

Surface water flow in Puerto Rico is along short, deeply incised streams that have steep gradients in the upper reaches, and generally radiate from the central highlands to the sea. Watersheds in Puerto Rico are generally smaller than those delineated in the contiguous United States (U.S.) due to the steep topography of the island; the island is broken into 96 watershed basins for management purposes (Figure 8.1.4-1). The orographic effect[2] of the steep topography in Puerto Rico causes precipitation to vary almost directly in relation to altitude; it is also affected by the prevailing wind direction (*Oki et al. 1999*).

Most of the streams along Puerto Rico's southern coast and its offshore islands are rainfall-fed, often with a flashy pattern of streamflow over time due to limited water storage in the small, steep watersheds and the intensity of rainfall (*Zack and Larsen 2004*). By comparison, streams that drain to the north and originate in the igneous and volcanic rocks of the interior are generally longer and have more consistent streamflow; the largest of these have the most flow during the dry season. However, with a few exceptions, even the largest streams of the island decline in flow to a trickle in the dry season. The northern and southern coastal streams especially are perennial in coastal areas where they are underlain by limestone and thick alluvium,[3] and water from the limestone and alluvial aquifers discharges to the streams as baseflow (*Zack and Larsen 2004*).

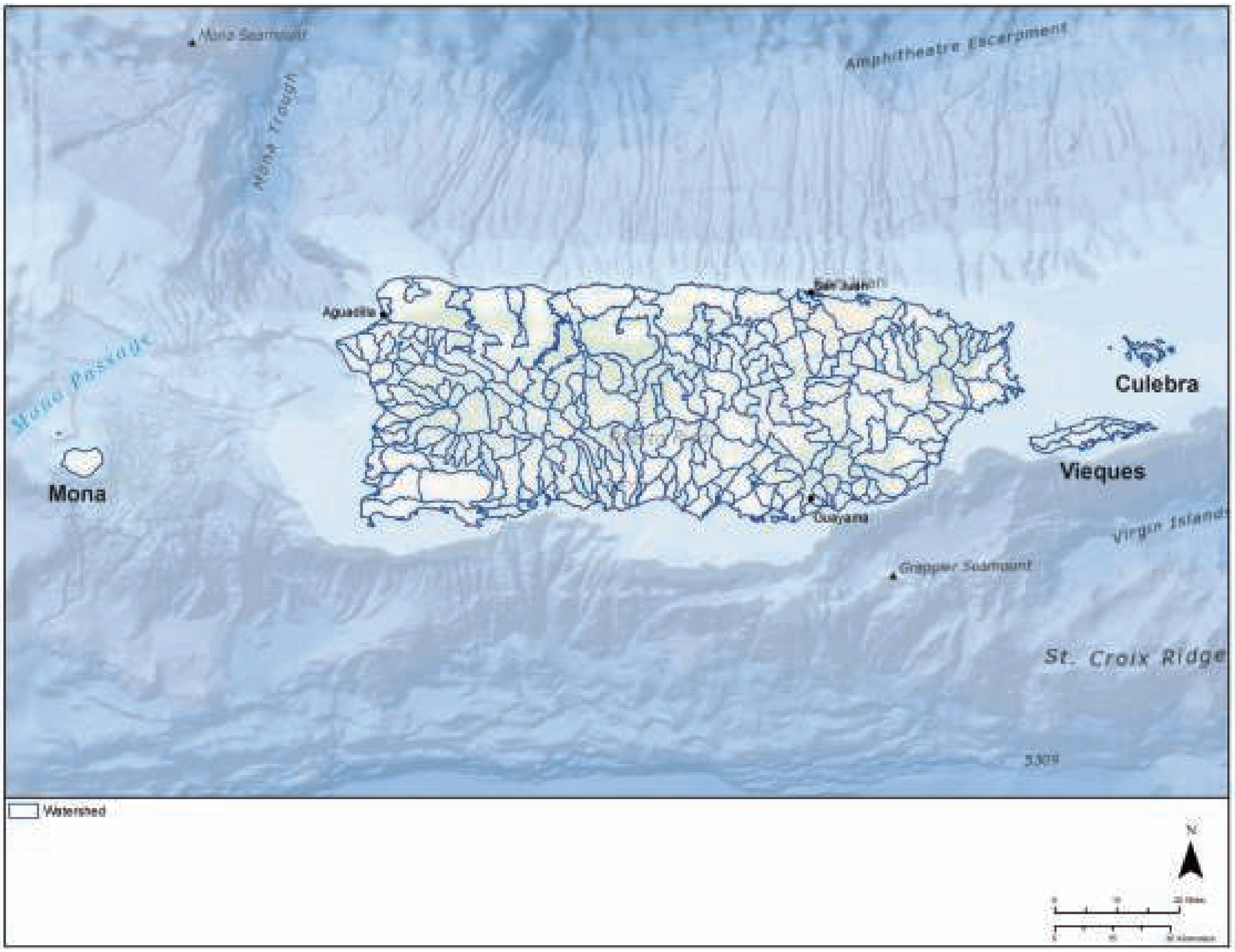
Figure 8.1.4-2 depicts the spatial distribution of major perennial and non-perennial streams in Puerto Rico. Surface water is the major source of drinking water in Puerto Rico, providing about 70 percent of its needs; groundwater supplies the remaining 30 percent (*USGS 1991; Zack and Larsen 2004*). Current human-caused stressors to Puerto Rico surface waters include (*PREQB 2014*):

- Land use impacts;
- Impoundments, which are typically used for water supply; many of these have become partly filled with sediment, reducing their effectiveness for both flood control and ware supply; and
- Pollution.

Water quality of surface waters in Puerto Rico is regulated according to the CWA. The state's inland waters are assigned to a set of water quality criteria, depending upon the beneficial uses that are to be protected. These areas are (*PREQB 2014*):

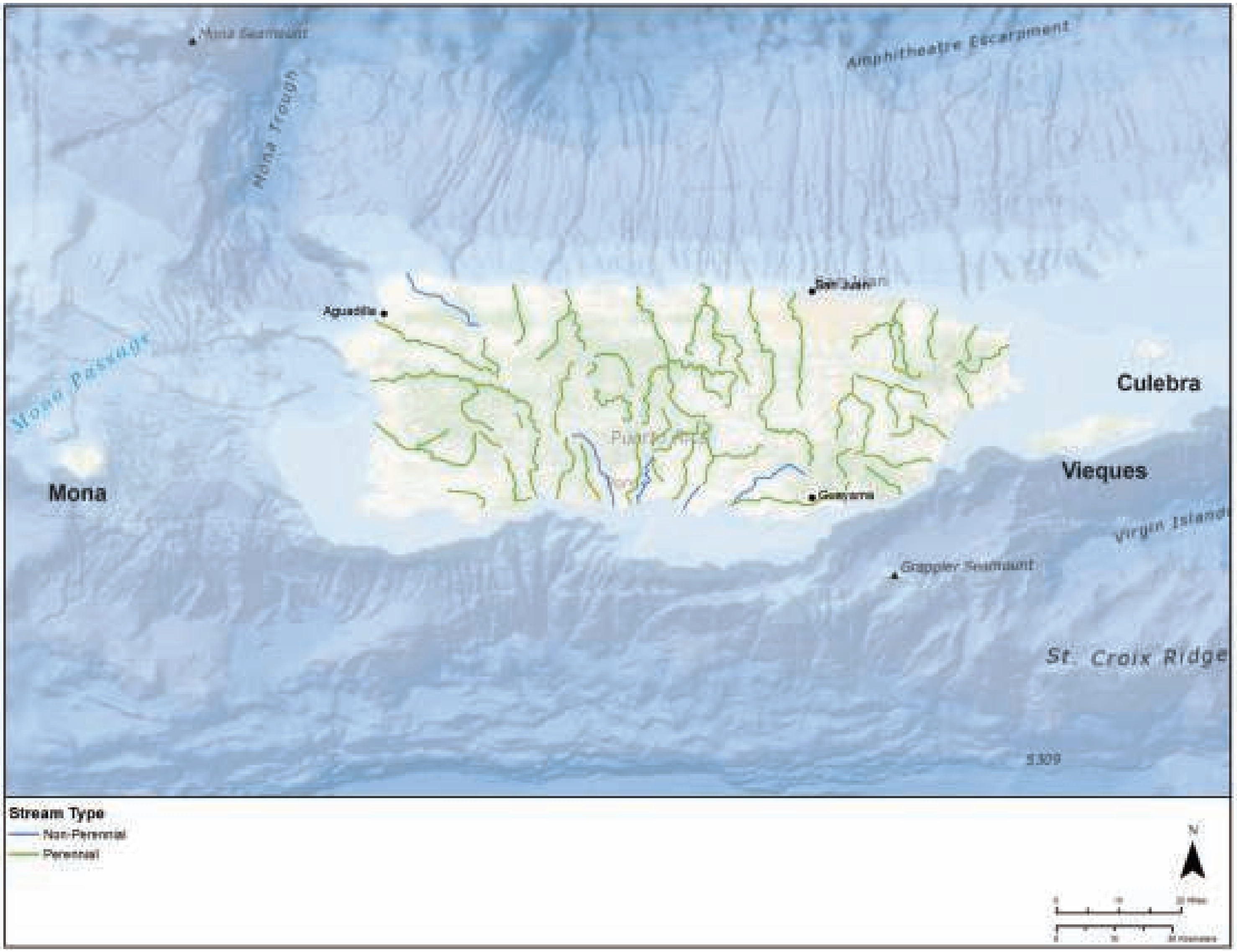
- Aquatic life (propagation and preservation of desirable species, including threatened and endangered species);
- Drinking water supply; and
- Primary and secondary contact recreation.

[2] The orographic effect is a change in atmospheric conditions caused by a change in elevation, primarily due to mountains.
[3] Alluvium is defined as sediment (clay, silt, sand, and/or gravel) deposited by flowing streams in a river valley.



Source: USDA Geospatial Data Gateway 2015

Figure 8.1.4-1: Spatial Distribution of Puerto Rico Watersheds



Source: USDA Service Center 2015

Figure 8.1.4-2: Spatial Distribution of Puerto Rico Streams

The U.S. Environmental Protection Agency's 303(d) and 305(b) integrated water quality report (*PREQB 2014*) describes water quality conditions for waters in Puerto Rico. A total of 2,269.8 miles of the territory's 5,052.8 acres of rivers and streams were found to be impaired. Impairments were generally for total coliform bacteria, which would negatively affect recreational use of these waterbodies. For drinking water, the most common cause of impairment was turbidity. For aquatic life, copper, low dissolved oxygen, and turbidity were the most common impairments. Total Maximum Daily Loads (TMDLs) are a regulatory tool used for impaired waterbodies, and describe a maximum amount of a pollutant that a waterbody can receive while still meeting water quality standards. TMDLs must be developed for all waterbodies on a state or territory's 303(d) list. TMDLs have been developed for 2,690.0 miles of streams, 54 acres of reservoirs, and 1.7 miles of reservoirs in Puerto Rico (*PREQB 2014*).

Sources of pollutants in Puerto Rico's streams and rivers are most often onside wastewater systems and urban runoff from storm sewers. Other frequent sources of pollution are confined animal feeding operations, minor industrial sources, and collection system failure by municipal sewage systems. A total of 7,269.0 acres and 134.4 miles of the territory's 7,323 acres and 134.4 miles of reservoirs were found to be impaired. The most common impairment found in lakes, reservoirs, and ponds is dissolved oxygen, followed by pollution from fecal coliform, copper, turbidity, pesticides, pH, and cyanide (*PREQB 2014*). Sources of this pollution are the same as for streams and rivers in Puerto Rico.

There are three Wild and Scenic Rivers in Puerto Rico: Río de la Mina, Río Icacos, and Río Mameyes (*NWSRS 2015*).

Floodplain Characteristics

Floodplains are lowland and flat areas adjoining inland and coastal waters. These areas are often prone to flooding, depending on streamflow amounts and timings. Flash flooding and landslides are the most dangerous hydrologic hazards in Puerto Rico. Flash flooding is common in the small, steep watersheds, where streams have narrow, shallow channels. Poor drainage on the floodplains increases the vulnerability of areas to flooding. Landslides are frequently triggered by these flooding events (*Zack and Larsen 2004*).

The FEMA maps 100-year floodplains on its NFIP Rate Maps, and defines 100-year floodplains as areas that have a 1 percent chance of being flooded in a given year. Regulations for 100-year floodplains include requirements for new development and substantial redevelopments of existing property to have certain flood resistant qualities. Flood insurance may also be required. Additionally, any fill of the floodplain by new development is limited, so as to not increase flood elevations elsewhere in the floodplain. The 500-year recurrence interval flood is also included on FEMA NFIP floodplain maps; however, these events are rare (with a 0.2 percent chance of occurring in a given year).

FEMA NFIP floodplain maps are available for most of the U.S. Often floodplain data are not available in areas where floodplain maps were not created because the areas are not flood prone (sometimes indicated as map "panels not printed"). Puerto Rico's NFIP maps are viewable online on FEMA's Map Service Center[4] (*FEMA 2015*), which allows the user to navigate to any location of the U.S. and, where data are available, zoom into any area to view flood zones. An example of flood data for Puerto Rico is provided in Figure 8.1.4-3. The land area shown in Figure 8.1.4-3 is at the northeastern side of Puerto Rico near San Juan. The figure shows coastal areas, inland stream areas, and inland reservoirs of low accumulation areas prone to flooding. Interested parties are directed to FEMA's Map Service Center to obtain more information on the location and extent of floodplains in Puerto Rico.

Nearshore Marine Characteristics

Puerto Rico contains 546.3 miles of shoreline, and 8.7 square miles of bays and harbors, as well as 3,430 acres and 107.8 stream miles that form parts of estuaries (*PREQB 2014*). Nearshore waters include estuaries,[5] bays and harbors, and recreational shorelines. Fresh water from streams, estuaries, and surface water runoff flows into nearshore marine waters. Land development and water use affect the way this water travels across the landscape, impacting both the quantity and quality of water reaching the coastal zone. Irrigation ditches increase the quantity of freshwater reaching the ocean (*PREQB 2014*).

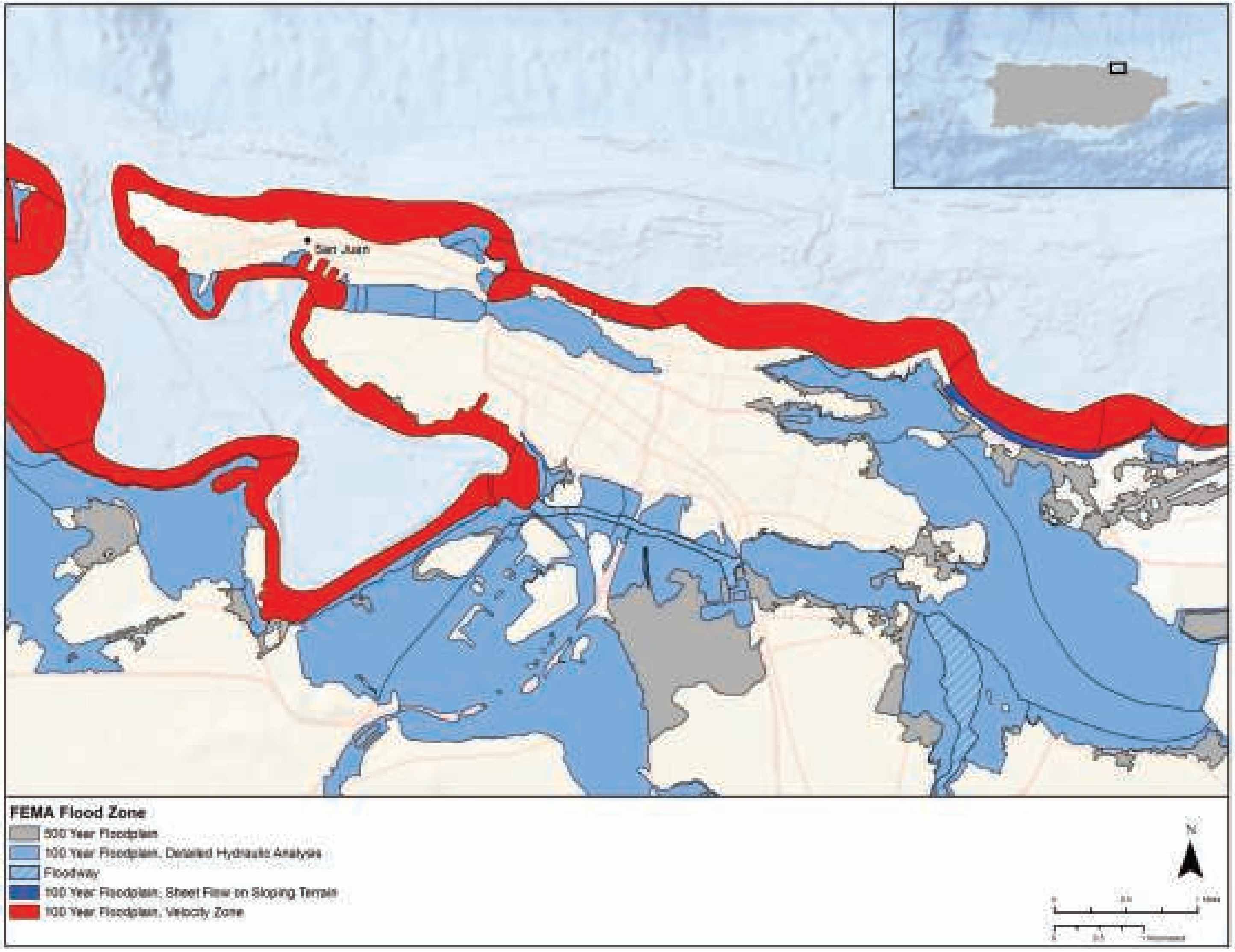
Marine waters are assessed for compliance with standards established for drinking water, recreation (primary and secondary recreation; biological indicators) and aquatic life (nutrient and biological) health. Sources of marine pollutants include polluted surface water runoff due to urban and agricultural inputs, as well as inputs from sewage systems (*PREQB 2014*).

A total of 8.7 square miles of Puerto Rico's bays and estuaries were assessed for water quality pollution; all were found to be impaired by at least one contaminant. The pollutant that most frequently exceeded water quality standards in marine waters is fecal coliform, with 94 percent of Puerto Rico's assessed marine waters exceeding the standard. Other pollutants often found in marine waters were dissolved oxygen, turbidity, total coliform and other pathogens, temperature, toxic inorganics, metals, and oil and grease (*PREQB 2014*).

In 2014, a total of 48.7 miles of Puerto Rico's shoreline was found to be impaired for primary contact recreation due to violation of the standard of enterococcus. Additionally, 492.5 miles of shoreline were impaired for aquatic life for violations for one or more of the following: dissolved oxygen, turbidity, pH, oil and grease, and temperature (*PREQB 2014*). Additionally, 102.4 acres of estuaries were found to be impaired due to fecal, total coliforms, and/or surfactants (*PREQB 2014*).

[4] https://msc.fema.gov/portal

[5] Estuaries are defined as coastal areas where salt water from the sea mixes with rivers and streams, and may be called bays, harbors, inlets, lagoons, or estuaries.



Source: FEMA 2015

Figure 8.1.4-3: Example Map of Puerto Rico Floodplains

Groundwater Characteristics

Groundwater is the water found underground in the cracks and spaces in soil, sand and rock. It is stored in and moves slowly through geologic formations of soil, sand and rocks called aquifers. Groundwater occurrence and quantities generally depend on geologic and hydrologic conditions. Puerto Rico is part of an island arc[6] that consists of faulted and folded volcanic and sedimentary rocks[7] that have been locally intruded by igneous rocks. Principal aquifers in Puerto Rico consist mostly of limestone, alluvium, or volcanic rocks. See Figure 8.1.4-4 for the spatial distribution of Puerto Rico's principal aquifers.

The principal aquifers in Puerto Rico are the North Coast aquifer system, the South Coast aquifer, and the alluvial valley[8] aquifers (*Oki et al. 1999*):

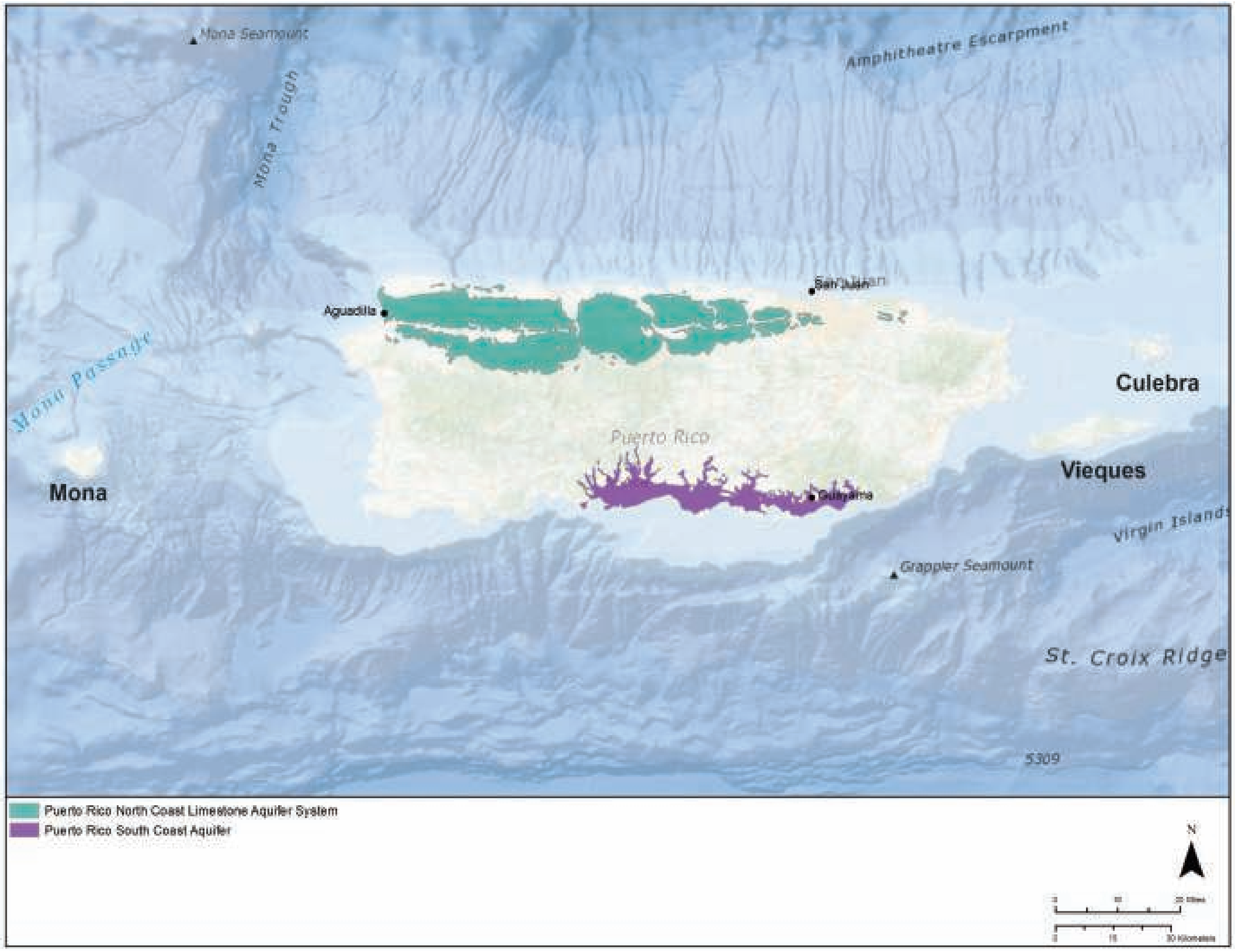
- The north coast aquifer system is an area underlain by limestone aquifers that are the most productive in Puerto Rico. These aquifers cover an area of about 600 square miles and are as much as 5,600 feet thick. The north coast aquifers consist of an upper, mostly unconfined, and a lower, mostly confined, aquifer.[9] This aquifer supplies water for most municipalities and industries located between Río Grande de Arecibo and the Río de la Plata (*Oki et al. 1999*).
- The south coast aquifer extends from Patillas west to Ponce, and consists of an alluvial aquifer that averages about 3 miles wide and is about 300 to 1,000 feet thick. This aquifer supplies about half of the south coast of Puerto Rico's public water supply and irrigation needs (*Oki et al. 1999*).
- The alluvial valley aquifers are found along the lower part of major river valleys on the east, west, north, and southwest coast areas as well as the east-central interior valleys of rivers near Cayey, Caguas, and Juncos. These are generally unconfined aquifers, where alluvium is present in valleys incised into limestone bedrock on the north and south coasts and into volcanic rocks in the interior. They are essential to the public water supply for many coastal municipalities; however, saltwater intrusion is a problem in areas with larger withdrawals. Most of the alluvial valley aquifers are located in the generally flat coastal areas of streams that originate on the steep-sided Cordillera Central and other mountain ranges. The seaward extent of these aquifers is bounded by a subsurface freshwater-saltwater interface and on the surface by a brackish water wetland or lagoon. Aquifer materials are generally sand and gravel interlayered with clay and silt (*Veve and Taggart 1996*).

[6] An island arc is a type of archipelago with an arc-shaped alignment. Island arcs are typically of volcanic origin.

[7] Sedimentary rocks are formed by the deposition of material at the Earth's surface and within bodies of water.

[8] Alluvial valleys are valleys formed by rivers.

[9] Confined aquifers are layers of groundwater that are generally bound above and below with impermeable layers of rock or sediment. Unconfined aquifers are not bound by such layers.



Source: USGS 2003

Note: Alluvial valley aquifers not shown on the figure are described above.

Figure 8.1.4-4: Spatial Distribution of Principal Aquifers in Puerto Rico

Aquifer recharge in Puerto Rico is generally from rain, but also from infiltration of stream flow; additionally leakage of metropolitan water, irrigation canals, and other conveyance losses provide variable amounts of discharge to groundwater in local areas (*Veve and Taggart 1996*). Generally, groundwater discharge to surface waters occurs in upland areas and near the coasts, with streams contributing to groundwater in other areas (*Veve and Taggart 1996*).

Contamination of surface and groundwater is a problem in most waterbodies in Puerto Rico. Only the deep artesian (naturally pressurized) aquifer on the north coast is free from downward percolating pollution; however, poorly constructed wells and heavy usage threaten its continued use and viability (*Zack and Larsen 2004*). There are no designated sole-source aquifers in Puerto Rico (*USEPA 2014)*.[10]

[10] The U.S. Environmental Protection Agency defines a sole-source aquifer as one that supplies at least 50 percent of the drinking water consumed in the area overlying the aquifer.

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8.1.5. Wetlands

8.1.5.1. Introduction

This section discusses wetland resources on Puerto Rico. Information is presented regarding wetland features and characteristics that would be potentially sensitive to impacts from deployment and operation of the Proposed Action.

Wetlands are a subset of Waters of the United States (U.S.), defined for regulatory purposes by the U.S. Environmental Protection Agency under the Clean Water Act (CWA) as those areas that are inundated or saturated by surface or groundwater at a frequency and duration sufficient to support—and that under normal circumstances do support—a prevalence of vegetation typically adapted for life in saturated soil conditions (*USEPA 2004*). Similarly, the U.S. Fish and Wildlife Service (USFWS) classification system (*Cowardin et al. 1979)* defines wetlands as "…lands transitional between terrestrial and aquatic systems where the water table is usually at or near the surface or the land is covered by shallow water…" (*Cowardin et al. 1979*). Wetlands can be vegetated or non-vegetated, but where vegetation is present, the plants are adapted for life in saturated or flooded soil. Examples of wetlands include marshes, bogs, ponds, intertidal areas, and estuaries.[1]

In contrast to wetlands, deepwater habitats (referred to as waters) are defined as any "permanently flooded lands lying below the deepwater boundary of wetlands" (*Cowardin et al. 1979*). Waters are typically non-vegetated, have a bed and bank, and include intermittent, ephemeral, or perennial streams,[2] rivers, or standing water (e.g., lakes or reservoirs). Waters are not included in this wetlands section, as they are discussed in Section 8.1.4, Water Resources.

The Environmental Protection Agency estimates that "more than one-third of the United States' threatened and endangered species live only in wetlands, and nearly half of such species use wetlands at some point in their lives" (*USEPA 1995*). In addition to providing habitat for many plants and animals, wetlands also provide benefits to human communities. Wetlands store water during flood events, improve water quality by filtering polluted runoff, help control erosion by slowing water velocity and filtering sediments, serve as points of groundwater recharge, and help maintain base flow in streams and rivers. Additionally, wetlands provide recreation opportunities for people, such as hiking, bird watching, and photography.

8.1.5.2. Specific Regulatory Considerations

Under Section 404 of the CWA (Section 404) activities that adversely affect Waters of the U.S., including wetlands, must be authorized through a Section 404 permit issued by the U.S. Army Corps of Engineers, and adverse impacts must be mitigated to the extent practicable (see

[1] Estuaries are defined as coastal areas where salt water from the sea mixes with rivers and streams, and may also be called bays, harbors, inlets, or lagoons.

[2] Intermittent streams carry water for part of the year (generally winter and spring), ephemeral streams carry water only as a result of precipitation (any time of year), and perennial streams normally have surface flow year-round in all or part of their course (under normal precipitation conditions) (*NCDEQ Undated*).

Section 1.8.7, Clean Water Act). There are eight coastally located National Wildlife Refuges on Puerto Rico.

The following government agencies are involved in local wetland management and regulation in Puerto Rico: Consolidated Farm Service Agency; U.S. Forest Service; Natural Resource Conservation Service; National Oceanic and Atmospheric Administration; U.S. Fish and Wildlife Service; National Park Service; U.S. Environmental Protection Agency; Department of Environmental and Natural Resources; and Conservation Trust of Puerto Rico (*USGS 1996*). The Puerto Rico Environmental Protection Agency has the final authority in approving or denying permit applications for construction work that would have environmental impacts.

8.1.5.3. Environmental Setting

As mentioned above, wetlands are recognized as important for maintaining watershed and environmental health due to their potential to perform various ecological, hydrologic, biogeochemical, and social functions, although not all wetlands perform these functions equally. Typical wetland functions include bank stabilization, flood mitigation, maintenance of water quality, maintenance of fish and wildlife habitat, sediment retention, groundwater discharge and recharge, and maintenance of nutrient retention and export. Their capacity or degree to which they perform individual functions depends on various wetland characteristics including soil type, substrate, type and percent cover of vegetation, water source, landscape position, location within a watershed, and location relative to populated areas (*USGS 1997*). As part of CWA Section 404 permitting, a wetland functional assessment is typically used to place wetlands into one of three categories, with Category 1 wetlands being the highest quality and/or functioning wetlands (and/or rare types); Category 2 wetlands being of moderate to high quality and/or function; and Category 3 wetlands being lower quality and/or functioning wetlands (and/or more common types). While a formal assessment of wetland functions and categorization is beyond the scope of this Final Programmatic Environmental Impact Statement, potential functions for Puerto Rico wetlands are discussed broadly in the section below.

The U.S. Geological Survey published a document titled *National Water Summary – Wetland Resources: Puerto Rico Wetland Resources* (*USGS 1996*). This document described Puerto Rico's climatic, hydrologic, and geologic setting as it relates to the formation of Puerto Rico's wetlands:

> "The subtropical climate, abundant rainfall, and complex topographic and geologic features of Puerto Rico give rise to wetlands ranging from the rare and unusual cloud forests in the highlands to extensive mangrove forests, seagrasses, and coral reefs along the northern and southern coasts.
>
> Hydrogeologic conditions differ throughout the island because of variations in the geology, topography, and climate. In the mountainous Cordillera Central and Sierra de Luquillo, which have peak elevations that exceed 4,300 feet above sea level, rainfall and runoff rates are high. The axis of the central mountain range, the Cordillera Central, trends east-west, and the core of the mountains is composed primarily of folded, faulted, intrusive volcanic rocks and sedimentary rocks. Along the

> northern flank of the mountains, a series of northward-dipping limestone formations dissected by streams and collapsed subterranean drainage features forms a band of mature karst topography that extends nearly to the coastline. These limestone formations constitute some of the most productive aquifers on the island.
>
> A flat coastal plain lies near the coast in many parts of the island. The coastal plain is particularly prominent along the southern coast where fan deltas from the southern drainages coalesce. In addition to alluvial fans, there are landslide, marine-terrace, coastal-dune, beach, swamp, and other recent deposits that overlie the older rocks on both the northern and southern coasts. On the eastern end of the island, the topography is characterized by steep-sided valleys and on the western end by broad, alluvial valleys that overlie volcanic rocks and limestone lenses."[3]

For specific information about Puerto Rico's soils, see Section 8.1.2, Soils. The water resources on Puerto Rico are discussed in more detail in Section 8.1.4, Water Resources.

Wetlands were assessed using the U.S. Fish and Wildlife Service National Wetland Inventory (NWI) (*USFWS 2015a*), which maps and classifies wetlands using the NWI classification system (*Cowardin et al. 1979*). NWI information for Puerto Rico was mapped using aerial imagery from the 1980s at a scale of 1 to 24,000. NWI mapping is created exclusively using geographic information system-based methods, with limited groundtruthing as required by the Federal Geographic Data Committee standards.[4] However, for the purpose of this broad scale PEIS, the NWI mapping is the best available territory-wide wetland mapping, and is considered to be of sufficient accuracy to assess wetland locations and type. The NWI mapping includes both wetlands and waters, although only wetlands are included in this section. For the purpose of this assessment, all areas that are classified by the NWI (per *Cowardin et al. 1979*) as either palustrine,[5] marine intertidal,[6] and estuarine intertidal[7] were included as wetlands. The remaining classifications were unvegetated waters and were not included in this assessment: marine subtidal, estuarine subtidal, lacustrine (lake-based), and riverine (river-based) (*Cowardin et al. 1979*). These waters areas are assessed in Section 8.1.4, Water Resources.

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[3] The complex topographic and geologic features have variable topography including mountains and coastal plains; the mature karst topography is a landscape of underground drainage systems of caves and sinkholes in dissolved limestone; an alluvial fan is sediment or debris in a fan shape deposited by streams and rivers, in this case at the mouth of rivers along the coast.

[4] Federal Geographic Data Committee standards website: http://www.fgdc.gov/standards

[5] Palustrine wetlands include all nontidal wetlands dominated by trees, shrubs, persistent emergent, emergent mosses or lichens, and all such wetlands that occur in tidal areas where salinity due to ocean-derived salts is below 0.5 parts per thousand.

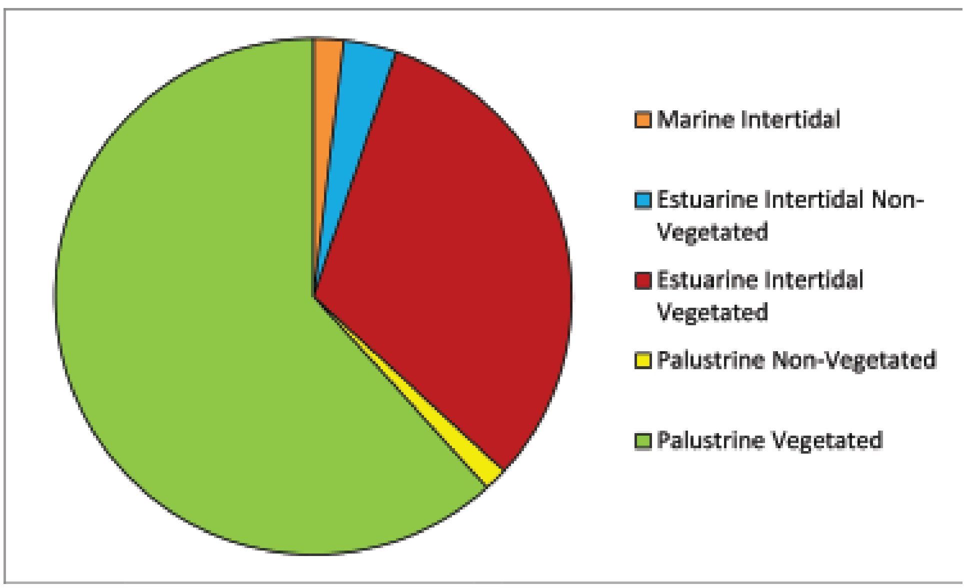
[6] Marine intertidal are areas of open ocean associated with high energy coastline where the substrate is exposed and flooded by tides (*Cowardin et al. 1979*).

[7] Estuarine intertidal are coastal areas usually semi-enclosed by land but have open partially-obstructed access to open ocean. Water is partially diluted by freshwater runoff.

8.1.5.4. Wetland Characteristics

A total of approximately 119,591 acres of wetlands are mapped for Puerto Rico, which represents 5.3 percent of the total area of the territory, slightly lower than the approximately 5.5 percent of total area comprised of wetlands in the contiguous U.S. as of 2009 (*Dahl 2011*) (see Table 8.1.5-1).

The majority of Puerto Rico's wetlands are classified as palustrine (75,566 acres), followed by estuarine intertidal (41,787 acres) and marine intertidal (2,239 acres) (see Figure 8.1.5-1). Nearly all of the estuarine and palustrine wetlands are vegetated, with estuarine scrub/shrub and palustrine scrub/shrub wetlands being the least common vegetated wetland types on the island. Of the estuarine vegetated wetlands, the vast majority are estuarine forested wetlands (which includes mangrove forests), followed by estuarine emergent. For the palustrine vegetated wetlands, the vast majority is palustrine emergent; palustrine forested wetlands are also common but present at about one fifth the acreage of palustrine emergent. Palustrine scrub/shrub wetlands are the least common palustrine wetland type (see Table 8.1.5-1) (*USFWS 2015a*). See Figures 8.1.5-2, 8.1.5-3, and 8.1.5-4 for photos of wetland types in Puerto Rico.



Source: USFWS 2015a

Figure 8.1.5-1: Puerto Rico Wetland Types

Table 8.1.5-1: Acreages, Types, and Descriptions of Wetlands in Puerto Rico

System[a]	Subclass[a]	Veg/Non-Veg	Class[a]	Code[a]	Approximate Acres	Physical Description	Hydrology	Vegetation
Marine	Intertidal	NA	All M2 classes	All M2 codes	2,238.8	Areas of open ocean associated with high energy coastline where the substrate is exposed and flooded by tides	Substrate exposed and flooded by tides; includes the splash zone	Typically unvegetated, or with some intertidal vegetation; includes seagrasses, algae, and corals
		Total Marine Intertidal			**2,238.8**			
Estuarine	Intertidal	Non-Vegetated	Aquatic bed; unconsolidated bottom; unconsolidated shore; rocky shore	E2AB, E2UB, E2US, E2RS	3,937.1	Coastal areas usually semi-enclosed by land but have open partially-obstructed access to open ocean; water is partially diluted by freshwater runoff	Substrate exposed and flooded by tides; includes the splash zone	NA
		Vegetated	Emergent; scrub/shrub; forested	E2EM, E2SS, E2FO	37,849.4			Herbaceous emergent, scrub/shrub, or forested vegetation Includes red, white, and black mangrove trees, buttonwood, mangrove fern, sea purslane, and saltwort
		Total Estuarine Intertidal			**41,786.5**			
Palustrine	NA	Non-Vegetated	Unconsolidated shore	PUS	13.6	Unvegetated freshwater wetlands that 1) lack active wave-formed or bedrock shorelines (e.g., lakes), 2) are <20 acres, and 3) are <6 feet deep at low water; substrate includes rock, sand, other fine materials, or vegetation growing below the water surface; includes ponds	Water <6 feet deep; hydrologic regime ranges from permanently flooded to seasonally/intermittently flooded, to saturated	NA
			Open water	PUB	1,622.2			NA
			Aquatic beds	PAB	131.4			Vegetation (e.g., duckweed or white water lily), algae, or moss growing below the water surface
		Total Palustrine Non-Vegetated			**1,767.1**			
		Vegetated	Emergent	PEM	59,785.3	Vegetated freshwater wetlands that 1) lack active wave-formed or bedrock shorelines (e.g., lakes), and 2) are dominated by vegetation, regardless of size; includes bogs, fens, marshes, swamps, and prairies	Hydrologic regime ranges from permanently flooded to seasonally/ intermittently flooded, to saturated	Marsh herbaceous vegetation growing above the water surface; includes grasses (e.g., sawgrass), cattail, giant sedge, and rushes (e.g., *Junco* or *Enea*)
			Scrub/shrub	PSS	3,246.1			Swamp or marsh scrub/shrub vegetation; Includes woody species such as *Palo colorado*
			Forested	PFO	10,767.4			Swamp forested vegetation; includes bloodwood forests, swampwood trees ferns, and *Palo colorado*
		Total Palustrine Vegetated			**73,798.8**			
		Total Palustrine			**75,565.9**			
Total Wetlands					**119,591.2**			

Sources: USFWS 2015a; Cowardin et al. 1979; de Jesus 2012; USGS 1996

NA= Not applicable
[a] System, subclass, class, and code are based on NWI Classification (*Cowardin et al. 1979*), as follows:
- Marine intertidal: M2: marine intertidal
- Estuarine intertidal: E2AB: estuarine intertidal aquatic bed; E2UB: estuarine intertidal unconsolidated bottom; E2US: estuarine intertidal unconsolidated shore; E2RS: estuarine intertidal rocky shore
- Palustrine
  - Non-vegetated: PUS: palustrine unconsolidated shore; PUB: palustrine unconsolidated bottom; PAB: palustrine aquatic bed
  - Vegetated: PEM: palustrine emergent; PSS: palustrine scrub-shrub; PFO: palustrine forested

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Photo taken on Puerto Rico; source: NOAA 2009

Figure 8.1.5-2: Marine Intertidal Wetland on Puerto Rico

Photo taken on Puerto Rico; source: NOAA 2013

Figure 8.1.5-3: Estuarine Intertidal Wetland on Puerto Rico

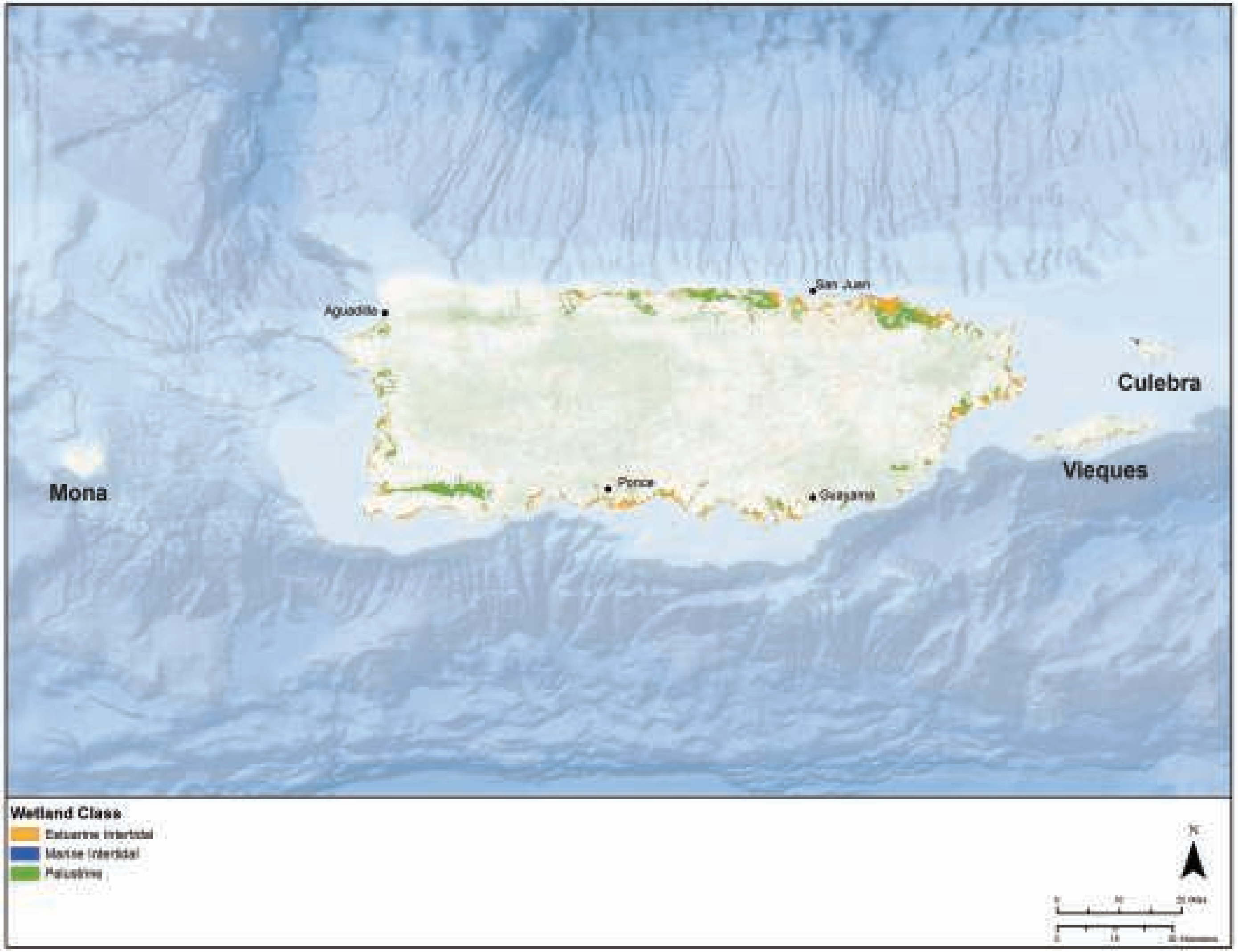
Photo taken at Laguna Cartagena USFWS National Wildlife Refuge on Puerto Rico; source: USGS 2014

Figure 8.1.5-4: Palustrine Wetland on Puerto Rico

Figure 8.1.5-5 depicts the spatial distribution of wetland types on Puerto Rico. NWI-mapped wetlands on Puerto Rico are concentrated in the coastal regions. The NWI also maps several small palustrine wetlands in the interior of the country that are too small to be visible on Figure 8.1.5-5. In addition, a review of representative streams shown in the aerial imagery for the interior of the country revealed that there are likely palustrine wetlands present as fringes along the streams and rivers that are not mapped as part of the NWI given the mapping scale; the NWI maps these fringe wetland features as part of the Riverine class.[8]

The *National Water Summary – Wetland Resources: Puerto Rico Wetland Resources (USGS 1996)* also lists some of the specific, larger wetland areas on Puerto Rico. Freshwater marsh areas include Laguna Tortuguero near Manati, Cano Tuburones near Arecibo, Laguna Cartagena at Lakas, Cienaga de San Pedro and Cienaga de las Cucharillas on the north coast, and Cienaga Baja near Río Grande. The largest mangrove forest is located east of San Juan.

[8] See Section 8.1.4, Water Resources, for a description of rivers and other surface waters in Puerto Rico.



Source: USFWS 2015a

Figure 8.1.5-5: Spatial Distribution of Puerto Rico Wetland Types

De Jesus (*2012*) and the U.S. Geological Survey (*USGS 1996*) provide a detailed discussion of several functions provided by Puerto Rico's wetlands. These include:

- Shoreline stabilization;
- Erosion protection;
- Barriers to storm surges and wave action;
- Flood water storage;
- Fish and crustacean nurseries;
- Water supply for cities;
- Food production;
- Provide recreational and educational opportunities;
- Enhance water quality; and
- Habitat for rare and endangered species.

Wetlands in Puerto Rico have been heavily degraded and destroyed from dredging, filling, draining, eutrophication,[9] and the use of agricultural fertilizers and pesticides (*USGS 1996*; *de Jesus 2012*). Other stressors to Puerto Rico's wetlands include sea level rise, hurricanes and storms, erosion, dredging and stream channelization, filling for road construction and development, effluent and runoff, mining of gravel, limestone, sand, and other materials (*de Jesus 2012*). Certain wetland types may be more sensitive to stressors than others, or may be more difficult to restore or rehabilitate structure and function after disturbance. For example, vegetated wetlands such as mangrove forests would be more difficult to restore than non-vegetated wetlands, with forested wetlands being the most difficult to restore given the time required for trees to grow, followed by scrub/shrub and emergent wetlands. Similarly, Puerto Rican wetlands that support coral reefs would also be difficult to restore.

The National Oceanic and Atmospheric Administration has developed a national set of Environmental Sensitivity Index (ESI) maps that includes Puerto Rico. The ESI maps present coastal area resources that may be at risk in the event of an oil spill. These maps provide a sensitivity index for areas considered to be sensitive shorelines, including coastal wetlands, wetlands providing habitat for sensitive or special status plant and wildlife species, and coral reefs (*NOAA 2015*). The ESI maps could therefore be used as a tool to determine potentially sensitive wetland habitats in coastal areas.[10]

[9] Eutrophication is a process where waterbodies receive excess nutrients that stimulate excessive plant growth.
[10] ESI maps and downloadable data: http://response.restoration.noaa.gov/maps-and-spatial-data/environmental-sensitivity-index-esi-maps.html

There are several land designations on Puerto Rico where wetlands are protected or actively managed. Five of Puerto Rico's National Wildlife Refuges (NWR) contain a significant amount of wetland or coastal habitat: Cabo Rojo NWR, Culebra NWR, Laguna Cartagena NWR, Navassa Island NWR, and Vieques NWR (*USFWS 2015b*). The salt flats of Cabo Rojo, on the southwestern coast, provide resting and feeding areas for thousands of migratory shorebirds en route between North and South America (*USGS 1996*). The Tortuguero Lagoon National Reserve is a protected wetland with nearly 700 plant species (*USGS 1996*), of which 69 are rare and endangered species (*de Jesus 2012*). The Pterocarpus Forest is a 51-acre private forested wetland nature reserve located near Humacao on the eastern coast of the island (*Pterocarpus Forest Project 2015*).

The wetlands of the central highlands are the last stronghold of the endangered Puerto Rican parrot (*Amazona vittata*) (*USGS 1996*). Coastal wetland areas support species of special concern such as the hawksbill turtle (*Eretmochelys imbricata*), leatherback turtle (*Dermochelys coriacea*), yellow-shouldered blackbird (*Agelaius xanthomus*), brown pelican (*Pelecanus occidentalis*), masked duck (*Nomonyx dominicus*), West Indian whistling duck (*Dendrocygna arborea*), and white-crowned pigeon (*Patagioenas leucocephala*) (*USGS 1996*). Specific information on wetland habitat for threatened and endangered species is presented in Section 8.1.6.6, Threatened and Endangered Species and Species of Conservation Concern.

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8.1.6. Biological Resources

8.1.6.1. Introduction

Biological resources include 1) terrestrial vegetation, 2) wildlife, 3) fisheries and aquatic habitats, and 4) threatened and endangered species and species of conservation concern. Wildlife habitat and associated biological ecosystems are also important components of biological resources. This section discusses the following existing biological resources in Puerto Rico:

- Terrestrial vegetation (Section 8.1.6.3), including vegetation types, vegetation communities of conservation concern, and invasive species.
- Wildlife (Section 8.1.6.4), including wildlife habitat and seasonal characteristics. Species included in this section are terrestrial invertebrates; amphibians and reptiles; terrestrial mammals (game and non-game); marine mammals; and birds occurring in Puerto Rico and in Puerto Rico's offshore environment. Wildlife species and their habitat in Puerto Rico are generally discussed along with select principal species or those of particular interest.
- Fisheries and aquatic habitats (Section 8.1.6.5), including fisheries features and characteristics. Species included in this section include freshwater and marine species of fish and shellfish occurring in Puerto Rico and in Puerto Rico's offshore environment.
- Threatened and endangered species and species of conservation concern (Section 8.1.6.6). This analysis considers plant and animal species that are federally listed as threatened, endangered, candidate, proposed, or species of concern; species listed by the United States Forest Service and the Bureau of Land Management as sensitive; species that are state-listed as endangered; and/or species that receive specific protection defined in federal or state legislation. This analysis considers species that are known to occur in Puerto Rico for all or part of their life cycle.

Potential impacts to these biological resources in Puerto Rico associated with deployment and operation of the Proposed Action are evaluated in Section 8.2.6, Biological Resources.

8.1.6.2. Specific Regulatory Considerations

Given the expected nature and extent of the Proposed Action, a range of biological resources could potentially be impacted to varying degrees. Therefore, many federal, state/territory, and local laws and regulations as well as executive orders are considered as part of this analysis. Each biological resource in this section contains a brief discussion of laws and regulations specific to it. Appendix C, *Environmental Laws and Regulations*, provides a comprehensive list of all applicable laws and regulations that were considered as part of the Proposed Action. Section 1.8, Overview of Relevant Federal Laws and Executive Orders, also provides an explanation of the major federal laws and executive orders that are relevant to the Proposed Action.

8.1.6.3. Terrestrial Vegetation

Introduction

This section discusses terrestrial vegetation resources in Puerto Rico. Information is presented regarding vegetation types and characteristics that would be potentially sensitive to impacts from deployment and operation of the Proposed Action.

Specific Regulatory Considerations

Related to terrestrial vegetation, and as addressed in Appendix C, *Environmental Laws and Regulations*, Executive Order (EO) 13112 "directs federal agencies to prevent the introduction of invasive plant and other species, provide for their control, and minimize the economic, ecological, and human health impacts that invasive species can cause."

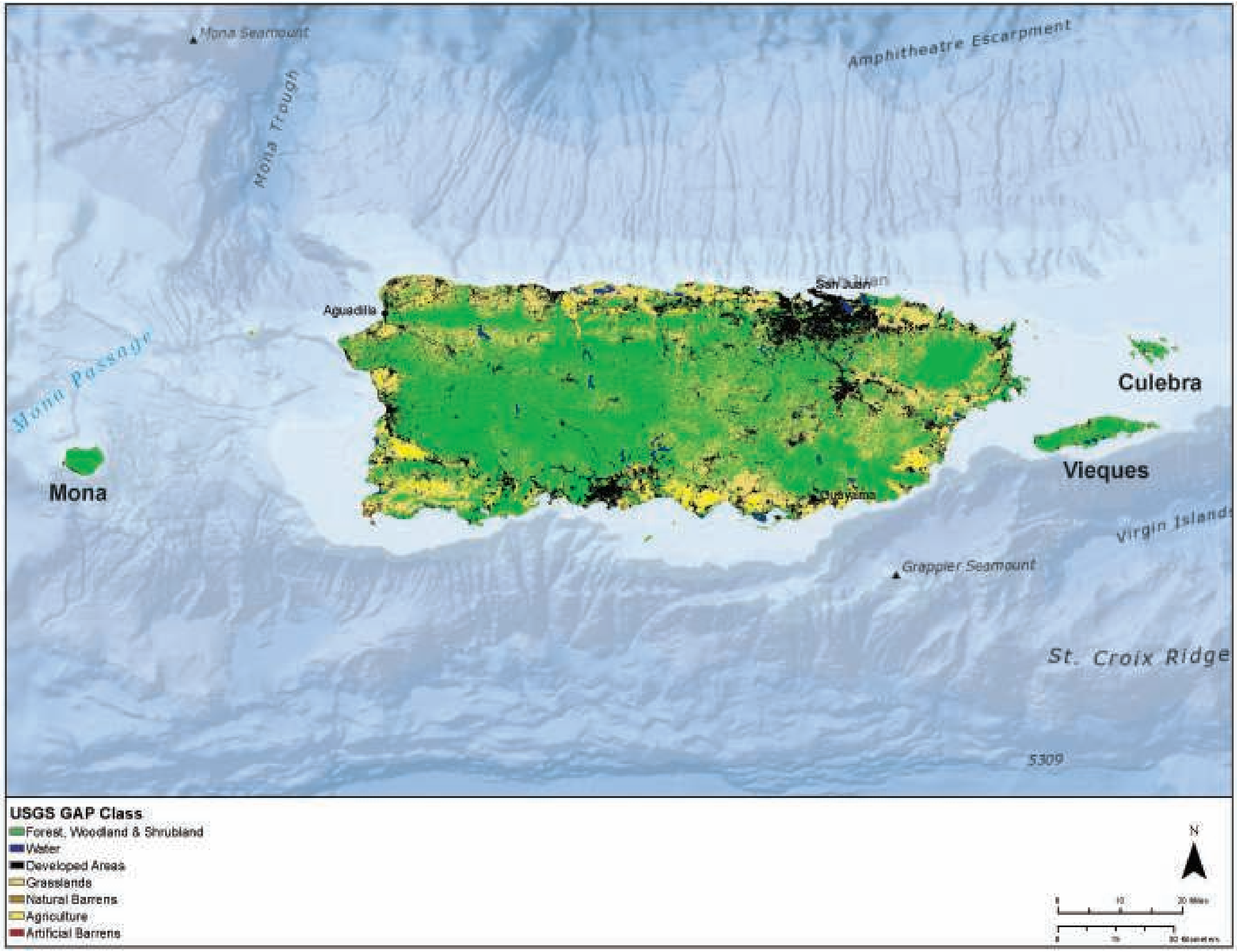
Environmental Setting

The vegetation types present in Puerto Rico were identified, evaluated, and described using information gathered from the Puerto Rico Gap Analysis Project, which was developed through research at the United States (U.S.) Department of Agriculture Forest Service International Institute of Tropical Forestry (*USFS 2006*). Supplemental vegetation mapping information and class descriptions were obtained and summarized from Gould et al. (*2008*).

In addition, vegetation communities of conservation concern were identified and described using information provided by the U.S. Fish and Wildlife Service (*USFWS 2014*) and Gould et al. (*2011*). Finally, invasive plant species are summarized in this section based on information from the Global Invasive Species Database (*Undated*) and Rojas-Sandoval and Acevedo-Rodriguez (*2014*).

Vegetation Types

Based on the vegetation data provided by the Forest Service, seven different vegetation types or land cover classes were classified in Puerto Rico. Figure 8.1.6.3-1 depicts the distribution of these vegetation types or land cover classes in the territory, and Table 8.1.6.3-1 provides a description of each type and their typical vegetation characteristics.



Source: USFS 2006

Figure 8.1.6.3-1: Vegetation Types and Land Cover Classes in Puerto Rico

Table 8.1.6.3-1: Vegetation Types/Land Cover Classes in Puerto Rico

Vegetation Type or Land Cover Class Name	General Description	Vegetation Characteristics
Forest, Woodland, and Shrubland	Woody vegetation; consists of mature and secondary forest growth and shrubs	Dominated by low and mid-elevation moist forests and upper elevation wet forests
Water	Open water	NA
Developed Areas	Includes high and low intensity urban and built-up areas	NA
Grasslands	Most areas are maintained in a disturbed state including by cattle grazing and burning	Various grasses
Natural Barrens	Consists of rocky cliffs, barren beaches and shoreline, and salt and mudflats	NA
Agriculture	Consists of areas with vegetation used for food crops, fruit, and other products or crops	Includes hay and row crops as well as woody agriculture and plantations such as palms
Artificial Barrens	Includes salt production areas and other areas made barren by artificial disturbance	NA

Source: USFS 2006; Gould et al. 2008

NA = not applicable

As shown in Figure 8.1.6.3-1, the majority of Puerto Rico is covered by woody vegetation. According to Gould et al. (*2008*), 53 percent of the land cover consists of forest, woodland, and shrub land vegetation (woody vegetation); 35 percent is grassland or herbaceous[1] agriculture; 11 percent is developed land; and 1 percent of Puerto Rico is freshwater or barren land. Currently, major threats to terrestrial vegetation in Puerto Rico include human development and associated forest fragmentation, wildfires, hurricanes, climate change, invasive species, and pests and diseases (*Government of Puerto Rico Undated*).

Vegetation Communities of Conservation Concern

Some vegetation communities or types have become of conservation concern because of declining abundance, sensitivity to disturbance, and/or due to the reliance of certain species on the habitat they create. There are currently 50 plant species protected under the Endangered Species Act in Puerto Rico (see Section 8.1.6.6, Threatened and Endangered Species and Species of Conservation Concern).

As further discussed in Section 8.1.6.4, Wildlife, 8 percent of Puerto Rico's land has been designated for conservation with a total of 116 protected natural areas (*Gould et al. 2011*). These conservation areas include public and private properties classified as territory forests, national federal forests, wildlife refuges, natural reserves, natural protected areas, conservation easements, recently acquired lands for conservation, and other lands managed for conservation. The Commonwealth of Puerto Rico owns and manages almost 60 percent of these areas,

[1] Herbaceous plants do not have woody stems.

followed by the federal government (28 percent), and non-governmental organizations (*Gould et al. 2011*). Section 8.1.6.4, Wildlife, addresses specific vegetation or habitat areas that are important for wildlife habitat including the Cabo Rojo Salt Flats, the Jobos Bay Natural Reserve, the Mona Passage, the Puerto Rican karst areas, and the Guánica Commonwealth Forest.

Invasive Species

EO 13112 defines an invasive species as a species not native to an area whose introduction causes or is likely to cause harm to the economy or the environment, or harms animal or human health. As mentioned above, the EO "directs federal agencies to prevent the introduction of invasive species, provide for their control, and minimize the economic, ecological, and human health impacts that invasive species can cause."

According the Global Invasive Species Database,[2] there are 80 invasive plant species identified in Puerto Rico (*Global Invasive Species Database Undated*). A recent scientific article identified a combined 177 invasive species in Puerto Rico and the U.S. Virgin Islands, representing just over 17 percent of the total plant species present on the islands (*Rojas-Sandoval and Acevedo-Rodriguez 2014*).[3] Of the 177 species identified, the following are some examples of those found in Puerto Rico, some of which are more susceptible to becoming established in disturbed areas than others (*Rojas-Sandoval and Acevedo-Rodriguez 2014; Global Invasive Species Database Undated*):

- Centipede tongavine (*Epipremnum pinnatum*) – Common escaped garden vine that climbs up tree trunks and forest canopy; primarily found in disturbed areas and along roads; smothers native plants; poisonous when eaten and can cause skin irritation.
- Wild tamarind/acacia palida/zarcilla/tangantangan (*Leucaena leucocephala*) – Introduced tree for beneficial uses including reforestation and windbreaks but has become an aggressive invader in disturbed areas; forms dense thickets and is difficult to eradicate once established; threatens and out-competes native plants.
- African evergreen (*Syngonium podphyllum*) – Ornamental vine that displaces native plants and grows over native trees; occurs in natural and planted forests, disturbed and urban areas, wetlands, and scrub/shrublands.
- Malabar plum (*Syzgium cumini*) – Small tree introduced into new areas as an ornamental shade tree; threatens and competes with native plants; occurs in natural and planted forests and riparian zones.[4]
- Para grass/buffalo grass (*Urochloa maxima*) – Grass found in canals and low wet areas; displaces native vegetation in swamps and marsh areas.

[2] The Global Invasive Species Database is managed by the Invasive Species Specialist Group of the International Union for Conservation of Nature Species Survival Commission. It is supported through partnership with the National Biological Information Infrastructure, Manaaki Whenua-Landcare Research, and the University of Auckland.

[3] The area studied in this research effort included Puerto Rico, the U.S. Virgin Islands, and the British Virgin Islands.

[4] Riparian zones are areas near wetlands, rivers, or streams.

8.1.6.4. Wildlife

Introduction

This section discusses the existing wildlife resources in Puerto Rico. Information is presented regarding wildlife habitat and characteristics that would be potentially sensitive to impacts from deployment and operation of the Proposed Action.

Species reviewed in this section, although not inclusive, represent the major taxonomic groups including terrestrial invertebrates, amphibians and reptiles, terrestrial mammals, marine mammals, and birds occurring in Puerto Rico and in Puerto Rico's offshore environment. The only native terrestrial mammal in Puerto Rico are bats; 13 bat species occur in Puerto Rico (*Gannon et al. 2005*). Several whale and dolphin species occur in the Caribbean Sea. For more information about water and wetlands, see Section 8.1.4, Water Resources, and Section 8.1.5, Wetlands. For more information on threatened and endangered species of wildlife, see Section 8.1.6.6, Threatened and Endangered Species and Species of Conservation Concern.

Specific Regulatory Considerations

The Puerto Rico Department of Natural and Environmental Resources (DNER), the United States (U.S.) Department of Agriculture Forest Service (USFS) and the U.S. Fish and Wildlife Service (USFWS), and the National Oceanographic and Atmospheric Administration's National Marine Fisheries Service (NMFS) are the primary managing agencies of Puerto Rico's terrestrial and marine wildlife.

The DNER, through the Bureau of Fisheries and Wildlife, manages terrestrial wildlife, except for threatened and endangered species, which are managed by USFWS and are protected by the Endangered Species Act (ESA).[1] In addition to threatened and endangered species, the USFWS is responsible for managing several federal wildlife refuges, such as Desecheo, Vieques, and Cabo Rojo. NMFS manages marine mammals and protected marine species of Puerto Rico, except for the West Indian manatee (*Trichechus manatus*) which is managed by the USFWS. DNER's Terrestrial Resources Division manages Puerto Rico's game species including migratory waterfowl, columbids (doves and pigeons), feral goats, and pigs (*García et al. 2005*). The Terrestrial Resources Division also evaluates the potential impacts of development on wildlife species and their habitats. Personnel from this Division provide technical guidance about proposed actions in accordance with regulations. The USFS is responsible for protecting and managing the Caribbean National Forest (El Yunque), the largest forest reserve in Puerto Rico (*Joglar et al. 2007*).

Guidance on compliance with Puerto Rico's government wildlife and habitat regulations can be found on the Puerto Rico DNER website.[2]

[1] The ESA is discussed in Section 1.8, Overview of Relevant Federal Laws and Executive Orders, and within the Specific Regulatory Considerations sub-section of Section 8.1.6.6, Threatened and Endangered Species and Species of Conservation Concern.

[2] http://www.drna.gobierno.pr/

Bald and Golden Eagle Protection Act

Bald and golden eagles are federally managed through both the Migratory Bird Treaty Act (MBTA) and the Bald and Golden Eagle Protection Act (BGEPA). The BGEPA affords specific legal protection to bald eagles (*Haliaeetus leucocephalus*) and golden eagles (*Aquila chrysaetos*). Under this Act, it is a violation to "…take, possess, sell, purchase, barter, offer to sell, purchase or barter, transport, export or import, at any time or in any manner any bald eagle commonly known as the American eagle or any golden eagle, alive or dead, or any part, nest, or egg thereof…" (*16 USC § 668*). The BGEPA defines "take" as pursuing, shooting, shooting at, poisoning, wounding, killing, capturing, trapping, collecting, molesting, or disturbing (*16 USC § 668c*). "Disturb" is defined in regulation *50 CFR § 22.3* as the following:

> "...[T]o agitate or bother a bald or golden eagle to a degree that causes, or is likely to cause, based on the best scientific information available, (1) injury to an eagle, (2) a decrease in its productivity by substantially interfering with normal breeding, feeding, or sheltering behavior, or (3) nest abandonment, by substantially interfering with normal breeding, feeding, or sheltering behavior." (*50 CFR § 22.3*)

In fall 2009, USFWS implemented two rules (*50 CFR §§ 22.26-22.27*) authorizing limited legal take of bald and golden eagles "when the take is associated with, but not the purpose of an otherwise lawful activity, and cannot practicably be avoided" (*USFWS 2011*).

Legal take of these species must be authorized through a USFWS permitting process, which would include site-specific reviews for projects that are to be completed within bald and golden eagles' preferred habitat.

Migratory Bird Treaty Act

A migratory bird is any individual species or family of birds that crosses international borders at some point during their annual life cycle to live or reproduce. The MBTA implements four treaties that prohibit take, possession, transportation, and importation of all migratory, native birds (plus their eggs and active nests) occurring in the wild in the U.S., except for house sparrows, European starlings, rock pigeons, any recently listed unprotected species in the *Federal Register* (*70 FR 12710*), and non-migratory upland game birds, except when specifically authorized by the USFWS. The MBTA provides that it is unlawful to pursue, hunt, take, capture, kill, possess, sell, purchase, barter, import, export, or transport any migratory bird or any part, nest, or egg or any such bird unless authorized under a permit issued by the Secretary of the Interior. Some regulatory exceptions apply. "Take" is defined in regulations as: "pursue, hunt, shoot, wound, kill, trap, capture, or collect, or attempt to pursue, hunt, shoot, wound, kill, trap, capture, or collect" (*16 USC § 1532(19)*). In total, more than 1,000 bird species are protected by the MBTA, 58 of which can be legally hunted with a permit as game birds.

The MBTA addresses take of individual birds, not population-level impacts, habitat protection, or harassment. Failure to comply with the MBTA can result in criminal penalties. As authorized by the MBTA, the USFWS issues permits to qualified applicants for the following types of activities: falconry, raptor propagation, scientific collecting, special purposes (rehabilitation, educational, migratory game bird propagation, and salvage), take of depredating birds,[3] taxidermy, and waterfowl sale and disposal.

Marine Mammal Protection Act

The Marine Mammal Protection Act prohibits, with certain exceptions, the take of marine mammals in U.S. waters and by U.S. citizens on the high seas, as well as the importation of marine mammals and marine mammal products into the U.S.[4] The act defines "take" to mean "to hunt, harass, capture, or kill" any marine mammal or attempt to do so. Exceptions to the moratorium can be made through permitting actions for take incidental to commercial fishing and other non-fishing activities; for scientific research; and for public display at licensed institutions such as aquaria and science centers.

Other federal regulations and executive orders pertaining to wildlife resources are discussed in Section 1.8, Overview of Relevant Federal Laws and Executive Orders, and Appendix C, *Environmental Laws and Regulations*.

Terrestrial Habitats and Wildlife (Invertebrates, Mammals, Reptiles and Amphibians)

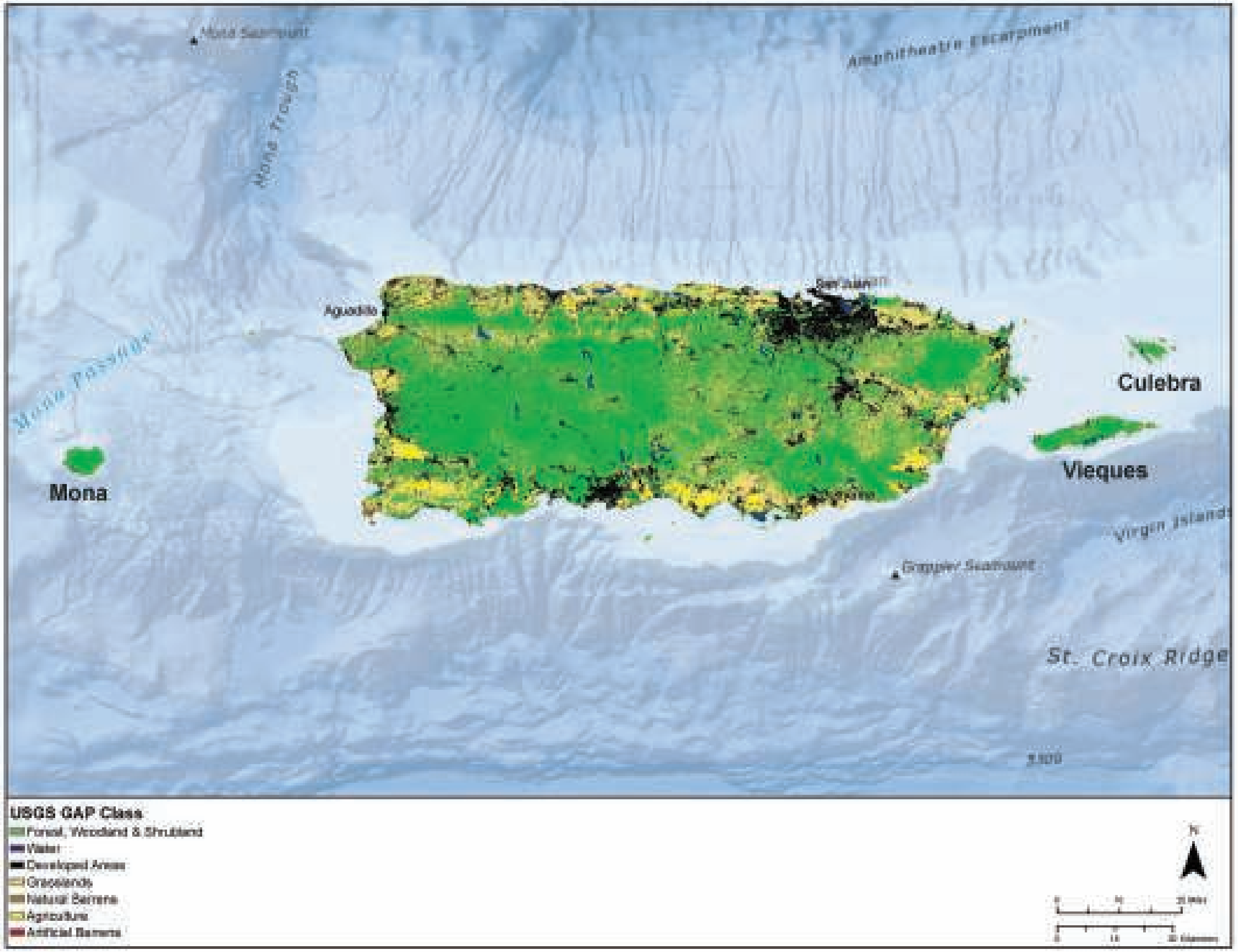
Habitats

The landscape of Puerto Rico is made up of a variety of ecosystems including subtropical dry to moist forest, karst,[5] woodlands, shrub lands, grasslands, wetlands, rocky shores, sandy beaches, and urban environments (*Gould et al. 2008*). General habitat types are shown in Figure 8.1.6.4-1. Additional information on land cover types are discussed in Section 8.1.6.3, Terrestrial Vegetation.

Forest and Woodlands

Forests of Puerto Rico include dry forest, rain forest, low-land forest, lower montane[6] forest, saltwater and freshwater forested wetlands, and forest on volcanic and karst substrates (*Miller and Lugo 2009*). Moist forests are the most abundant and extensive forest types in Puerto Rico (*Nytch et al. 2015*). Forest habitats are critical for providing food, flyways, freshwater, roosts, cover, and recovery from natural disasters for many species found on the islands (*Lindsay et al. 2009*; *Miller and Lugo 2009*).

[3] Depredating birds are birds that cause resource damage, economic loss, or a threat to health and human safety.
[4] The National Oceanic and Atmospheric Administration has consistently interpreted the Marine Mammal Protection Act as applicable to U.S. vessels and citizens throughout the high seas, including exclusive economic zones, as reflected in congressional and other correspondence and international agreements that rely upon jurisdiction over U.S. vessels and citizens in foreign exclusive economic zones (*16 USC §§ 1361-1423h*).
[5] Karst is terrain with distinctive landforms and hydrology created from soluble rock dissolution and characterized by springs, caves, sinkholes, and unique hydrogeology. (*USGS Undated*).
[6] Montane areas are mountainous areas.



Source: USGS GAP 2011

Figure 8.1.6.4-1: General Habitat Types in Puerto Rico

Grasslands and Shrub

Grasslands and shrub habitats became common throughout Puerto Rico as a result of human activities and include old agricultural fields, sugar cane lands, and pastured meadows among others. Dry grasslands peppered with woody shrub species make up the majority of this habitat, though seasonally flooded wetlands can also be found along riparian systems and coastal zones (*Gould et al. 2013*).

Wetlands and Marshes

Marshes and open water habitats include lakes; fresh, brackish, and saltwater lagoons; salt flats and mudflats; water reservoirs; and the permanently marshy vegetation surrounding them. Marshes are common throughout Puerto Rico (*Miller and Lugo 2009*). Freshwater turtles commonly inhabit lowland habitats such as rivers, lagoons, and ponds (*Miller and Lugo 2009*).

Beaches and Barrens

Bare beaches and non-vegetated riparian areas, rocky shores, rock crevices on cliffs, volcanic rocks and cays[7] provide key sites for nesting seabirds, reptiles (nesting for turtles and lizards), and invertebrate species. Cays are of particular importance to the native reptile species that have been extirpated. For example, the rock iguana is now restricted to offshore islands of Puerto Rico (*Miller and Lugo 2009*).

Caves or Karst

Karst regions are characterized by the presence of rocky ground, caves, sinkholes, and underground rivers. Caves or karst provide important natural roost sites for bats (*Lindsay et al. 2009*). Many species of amphibians, reptiles, and invertebrates are only found in karst ecosystems (*Lugo et al. 2001*).

These habitats harbor many species of terrestrial invertebrates, amphibians, reptiles, birds, and mammals creating a "global biodiversity hotspot" (*Myers et al. 2000*). The Puerto Rico Gap Analysis Project (*Gould et al. 2008*) indicates over 470 vertebrate species (excluding fish) have been recorded in Puerto Rico and its adjacent islands including terrestrial and aquatic birds, reptiles, amphibians, and mammals. Of these, about 436 species are terrestrial vertebrates including 328 birds, 57 reptiles, 27 mammals, and 24 amphibians (*Gould et al. 2008*).

Forty-seven of these species are listed as either federally threatened or endangered or given partial status, or are locally listed by the DNER as vulnerable, endangered, critically endangered, or data deficient (*Gould et al. 2008*). These are discussed in Section 8.1.6.6, Threatened and Endangered Species and Species of Conservation Concern.

Game species in Puerto Rico include migratory waterfowl, pigeons and doves, feral goats, and pigs (*García et al. 2005*).

[7] Cays are small, low-elevation, sandy islands on the surface of a coral reef.

Wildlife

Terrestrial Invertebrates

Approximately 5,847 species of invertebrates have been documented in Puerto Rico including insects, spiders, scorpions, millipedes, centipedes, snails, and slugs, among many others. As of 2005, no terrestrial invertebrate species were listed as species of conservation priority (*García et al. 2005*).

Amphibians and Reptiles

Eighty-six species of amphibians and reptiles are reported to occur in Puerto Rico, including 25 amphibians, 12 species of snakes, 37 lizard species, 4 worm lizard species, 5 sea turtles, and 3 common tortoises (*Caribherp 2015; USFWS 2015*). A list of amphibians and reptiles in Puerto Rico is reported by Joglar et al. (*2007*).[8] Listed species are discussed further in Section 8.1.6.6, Threatened and Endangered Species and Species of Conservation Concern.

Puerto Rico's amphibians are important ecologically and culturally. The tree frogs (*Eleutherodactylus spp.*), or coquís, are a national symbol and named after their distinctive calls heard throughout the island. They are primarily insectivorous[9] and one of the most important nocturnal predators on the island because of their abundance (*Gould et al. 2008*). Puerto Rican amphibians and reptiles have a high degree of endemism,[10] with many exclusive to the Greater Antillean island chain (*Joglar et al. 2007; Gould et al. 2008*). The reptiles of Puerto Rico are also important ecologically, serving as both prey and predator for a number of organisms (*Gould et al. 2008*).

Terrestrial amphibians and reptiles are found in a variety of habitats. The Puerto Rico coquís (*E. coqui*) inhabits forests, woodlands, and shrublands above 656 feet (200 meters) in the central mountains (*Gould et al. 2008*). The semi-aquatic white-lipped frog (*Leptodactylus albilabris*) occupies habitats near streams, ditches, marshes, and other freshwater sources (*Platenberg and Boulon 2006*). Ground lizards prefer dry, rocky coastal areas with sandy soils, leaf litter, and scrubby vegetation (*Platenberg and Boulon 2006*). The Puerto Rican boa (*Chilabothrus inornatus*) inhabits moist and wet forested areas or dense dry forest near water and is known to feed on domestic fowl, rodents, lizards, insects, and other invertebrates (*Gould et al. 2008*). Cays are of particular importance to the native reptile species, providing refuge habitat from otherwise colonized areas of invasive species (*Platenberg and Boulon 2006*).

Marine turtles in Puerto Rico, such as the commonly observed hawksbill turtle (*Eretmochelys imbricata*) and green sea turtle (*Chelonia mydas*), utilize beaches, shallow coastal areas, and reefs for feeding, breeding, and egg laying. Green sea turtles are herbivores, consuming seagrasses and algae; hawksbill turtles are carnivores, eating fish, crabs, snails, anemones, and jellyfish (*NOAA 2015a; NOAA 2015b*). The Puerto Rican freshwater turtle (*Trachemys stejnegeri*) is the only freshwater turtle native to Puerto Rico (*Joglar et al. 2007*). The exotic

[8] http://www.bdigital.unal.edu.co/4720/1/Joglar_et_al_2007_Ap_herpet.pdf
[9] Insectivorous animals feed on insects, worms, and other invertebrates.
[10] Endemism refers to a species that is only found in one area or region.

red-eared slider (*Trachemys scripta elegans*) has been released and is widespread in Puerto Rican wetlands (*Joglar et al. 2007*). Additional information related to marine turtle species that are listed as threatened or endangered, including the hawksbill green sea turtle, is included in Section 8.1.6.6, Threatened and Endangered Species and Species of Conservation Concern.

Terrestrial Mammals

Mammals in Puerto Rico include 13 living, native species, all of which are bats. These include one species of fishing bat (Noctilionidae), three species of mustached or ghost-faced bats (Mormoopidae), five species of leaf-nosed bats (Phyllostomidae), two species of plain-nosed bats (Vespertilionidae), and two species of free-tailed bats (Molossidae) (*Gannon et al. 2005*).

Most Puerto Rican bat species roost primarily in natural cavities. Mustached or ghost-faced bats typically roost in caves, forming large colonies containing thousands of individuals comprising of a number of different species (*Gannon et al. 2005*). The greater fishing bat (*Noctilio leporinus*) prefers coastal rock cavities and overhangs, and tree cavities (*Lindsay et al. 2008*). Two species, the Pallas' mastiff bat (*Molossus molossus*) and the Brazilian free-tailed bat (*Tadarida brasiliensis*), will use the space under the roofs of residences as roosts, while the Jamaican fruit-eating bat (*Artibeus jamaicensis*) and the Antillean cave bat (*Brachyphylla cavernarum*) may use ruins and abandoned buildings (*Lindsay et al. 2008*). Bats provide many ecological functions such as pollinators of floral species and important seed dispersal agents for fruit bearing trees and shrubs. Some bat species are important predators, consuming vast quantities of insects, including mosquitoes (*NPS 2015a*). The greater fishing bat eats fish and aquatic crustaceans (*Lindsay et al. 2008*).

Non-native terrestrial mammals of Puerto Rico include introduced domestic animals, pest species that arrived on vessels as stowaways, one of which was intended for pest control (i.e., the Indian mongoose [*Herpestes edwardsii*]), and one of which was brought to the islands for hunting purposes (i.e., the white-tailed deer [*Odocoileus virginianus*]) (*Gannon et al. 2005*). The domestic species that have become feral include dogs, cats, donkeys, pigs, cows, goats, and sheep (*Gould et al. 2013; NPS 2015b*). Introduced pest species include the black rat (*Rattus rattus*), Norway rat (*Rattus norvegicus*), and the house mouse (*Mus musculus*) (*Gould et al. 2013*). Four species of non-native monkeys escaped from rearing colonies, including the Rhesus monkey (*Macaca mulatta*), and have occupied the southwest coast (*Miller and Lugo 2009*).

Habitats and Marine Mammals

The Caribbean Environment Programme of the United Nations Environment Programme (*CEP-UNEP 2015*) describes the marine mammals of the Caribbean Sea:

> "At least 32 species of marine mammals have been documented from the region - six species of baleen whales (Mysticeti), 24 species of toothed whales (Odontoceti), one sirenian[11] (the West Indian manatee), and three pinnipeds[12] (the Caribbean monk seal, the hooded seal, and the California sea lion). For many of these species, waters of the region serve as primary habitat for critical activities that include feeding, mating and calving. Although some species have been studied extensively elsewhere, data are scarce concerning the biology, life history, distribution and behavior of most cetacean (whale and dolphin) and manatee populations in the Caribbean Sea and Gulf of Mexico."

Jefferson and Lynn (*1994*) reported sightings of several whale, dolphin, and porpoise species in the Caribbean Sea; these species include sperm whale (*Physeter macrocephalus*), Cuvier's beaked whale (*Ziphius cavirostris*), short-finned pilot whale (*Globicephala macrorhynchus*), rough-toothed dolphin (*Steno bredanensis*), bottlenose dolphin (*Tursiops* sp.), Atlantic spotted dolphin (*Stenella frontalis*), Pantropical spotted dolphin (*Stenella attenuata*), spinner dolphin (*Stenella longirostris*), and striped dolphin (*Stenella coeruleoalba*). NMFS currently monitors Puerto Rico and U.S. Virgin Island stocks of bottlenose dolphin, Cuvier's beaked whale, short-finned pilot whale, spinner dolphin, the Atlantic spotted dolphin, as well as the West Indian manatee Puerto Rico stock (Antillean subspecies, *Trichechus manatus manatus*) (*Waring et al. 2012*). Listed species, including five whale species and one manatee, among others, are discussed further in Section 8.1.6.6, Threatened and Endangered Species and Species of Conservation Concern. Marine ecosystems such as coral reefs, mangrove forests, and seagrass provide important habitat for marine mammals of Puerto Rico and are summarized below.

Coral reefs

Puerto Rico's coral reefs are found in many areas of the insular shelf but are most concentrated in two areas: the southwest in the Cabo Rojo/La Parguera area and the northeast from Fajardo to Culebra, Vieques, and the many small islets going east toward the U.S. Virgin Islands (*Miller and Lugo 2009*). Reefs are generally found in clear, warm tropical seas and grow best in shallow water less than 150 feet deep; waves and strong currents can be helpful to the health and sustainability of the coral (*UVI 2009*). Other major habitat types in the marine environment are submerged vegetation, uncolonized hardbottom (e.g., bedrock), and unconsolidated sediments (e.g., sand) (*UVI 2009*). The north coast has a narrow shelf, with deep water near shore and the coastline receiving heavy surf. It has little coral or well-developed seagrass beds (*Miller and Lugo 2009*).

[11] Sirenians are an order of fully aquatic, herbivorous mammals that inhabit swamps, rivers, estuaries, marine wetlands, and coastal marine waters.
[12] Pinnipeds, commonly known as seals, are a widely distributed and diverse group of fin-footed, semiaquatic marine mammals.

Seagrass Beds

Seagrass habitats are common in the coastal saltwater environment and predominant on the east and southern coast of Puerto Rico. Three dominant seagrass species in the U.S. Caribbean include: turtle grass, shoal grass, and manatee grass (*NOAA Undated*). These grasses prefer shallow areas with clear water which allow light penetration. Seagrass beds and patch reefs provide important forage and resting habitat for sea turtles and manatees.

Mangroves

Mangrove forests occur in the intertidal zones of the U.S. Caribbean, bordering the coastline, lagoons, and canals, and forming large forests in river deltas. Four common mangrove species dominate: red mangrove, black mangrove, white mangrove, and button mangrove (*UVI 2009*). Mangroves are flooded at least twice a day at high tides. Up to 75 percent of Puerto Rico's mangroves have been lost in past decades; however they are recovering in some places in Puerto Rico as a result of their protected status (*Miller and Lugo 2009*).

Habitats and Birds

Birds of Puerto Rico include 43 introduced species, of which 34 reproduce in the wild (*Delannoy 2005*), and 98 resident species, of which 19 are endemic[13] (*Gould et al. 2008*). The Puerto Rico Comprehensive Wildlife Conservation Strategy (CWCS) reports 81 bird species recognized as species of greatest conservation need (*Nytch et al. 2015*).

The USFWS also maintains a list of Birds of Conservation Concern (*USFWS 2008*) pursuant to the 1988 amendment to the Fish and Wildlife Conservation Act, which mandates that the USFWS "identify species, subspecies, and populations of all migratory nongame birds that, without additional conservation actions, are likely to become candidates for listing under the Endangered Species Act of 1973" (*16 USC § 2912*).

[13] Endemic refers to species that are only found in one area or region.

The USFWS Region 4 (Puerto Rico and U.S. Virgin Islands), U.S. Caribbean Islands list includes:

- West Indian whistling-duck
- White-cheeked pintail
- Masked duck
- Ruddy duck (*jamaicensis* ssp.)
- Audubon's shearwater
- Masked booby
- Brown booby
- Red-footed booby
- Magnificent frigatebird
- Least bittern
- American flamingo
- Black rail
- Yellow-breasted crake
- Caribbean coot
- Limpkin
- Snowy plover
- Wilson's plover
- American oystercatcher
- Red knot (*rufa* ssp.)
- Semipalmated sandpiper (Eastern)
- White-crowned pigeon
- Bridled quail-dove
- Antillean mango
- Loggerhead kingbird
- Puerto Rican vireo
- Elfin-woods warbler
- Greater Antillean oriole

Twenty Important Bird Areas (IBAs) are located on Puerto Rico. The IBAs support habitats for 52 bird species. Six species are globally threatened, 23 are restricted range species, and 28 are congregatory waterbirds or seabirds (*Nytch et al. 2015*). The *Avian Conservation Planning Priorities for Puerto Rico and the USVI (BCR 69)* (*Nytch et al. 2015*) Appendix F,[14] lists key bird species at IBAs in Puerto Rico.

The Atlantic Coast Joint Venture, with assistance from DNER, lists 20 sites recognized as Waterfowl Focus Areas (WFA) in Puerto Rico. Breeding, migrating, and wintering waterfowl priority species were identified for each WFA, in addition to other migratory, native, endemic, and exotic bird species reported in the selected areas (*Nytch et al. 2015*). Focus areas were selected primarily because of the presence of wetlands and lagoons optimal for the establishment of migratory waterfowl and because of the prodigious use of these habitats for feeding and roosting (*Nytch et al. 2015*).

Nytch et al. (*2015*) described the habitat types and associated key avian species and a summary of their discussion is provided below.

Forest and Woodland Habitats

The forest and woodlands of Puerto Rico are described as seven general forest types including Colorado, palm, and elfin forest; Tabonuco and secondary wet forest; karst forest; moist forest; dry forest and Serpentine forest; dry coastal forest; and forested coastal wetlands.

Colorado, palm, and elfin forests are located at high elevations (above 2,000 feet). Large, open-crowned trees dominate the Colorado forest type, while palm and cloud forest are found on stable mountaintops. There are 33 priority bird species for Puerto Rico that are associated with Colorado, palm and Elfin forest habitats, including the Puerto Rican parrot (*Amazona vittata*)

[14] http://acjv.org/documents/PRUSVI_plan.pdf

and Puerto Rican subspecies of broad-winged (*Buteo platypterus brunnescens*) and sharp-shinned (*Accipiter striatus venator*) hawks. The elfin woods warbler (*Setophaga angelae*), Bicknell's thrush (*Catharus bicknelli*), worm-eating warbler (*Helmitheros vermivorum*), Puerto Rican vireo (*Vireo latimeri*) are also common to this forest type (*Nytch et al. 2015*).

The Tabonuco and secondary wet forest assemblage is a diverse forest of closed canopies trees reaching 100 feet in height with many epiphytic[15] flowering plants, ferns, and orchids. These forests are found at elevations slightly lower than the cloud forest though they share similar bird associations. High priority species such as the Puerto Rican tanager (*Nesospingus speculiferus*), the plain pigeon (*Patagioenas inornata*), and the elfin woods warbler can be found in these lower elevation forests. Several Neotropical migrant species utilize the Tabonuco and secondary wet forest habitat for their wintering grounds such as the Cape May and black-throated blue warblers (*Setophaga tigrina* and *Setophaga caerulescens*) (*Nytch et al. 2015*).

The karst forest cover is highly variable, though generally characterized by an assemblage of evergreen and semi-deciduous trees. More than 75 species of Neotropical migrants use karst forest for wintering habitats (*Miller and Lugo 2009*). This forest type is prime habitat for the Puerto Rican subspecies of broad-winged and sharp-shinned hawks, the Puerto Rican vireo, the Puerto Rican oriole (*Icterus portoricensis*), and migrants such as the worm-eating warbler and the black-throated blue warbler.

Moist forests are the most abundant and extensive forest types in Puerto Rico, ranging from coastal plains up to approximately 1,000 feet. Plants and trees found in this forest are primarily evergreens intermixed with some deciduous species. The moist forest makes up significant portions of the ranges of important native species such as the black-whiskered vireo (*Vireo altiloquus*) and Antillean euphonia (*Euphonia musica*), as well as many local endemics such as the green mango (*Anthracothorax viridis*), Puerto Rican emerald (*Chlorostilbon maugeaus*), Puerto Rican lizard cuckoo (*Coccyzus vieilloti*), Puerto Rican screech-owl (*Megascops nudipes*), Puerto Rican spindalis (*Spindalis portoricensis*), and Puerto Rican tody (*Todus mexicanus*).

Dry forests are found at low to mid elevations on the south and southwest coasts of Puerto Rico. Open woodland and semi-deciduous scrubland are the predominant vegetation. Dry forest habitats are home to a broad suite of forest birds, including many restricted range species and at least ten island endemics. Dry forests are optimal habitats for the yellow-shouldered blackbird (*Agelaius xanthomus*), white-crowned pigeon (*Patagioenas leucocephala*) and Puerto Rican vireo. Serpentine forests are found only in southwestern Puerto Rico and are home to the Puerto Rican nightjar (*Antrostomus noctitherus*).

Dry coastal forest habitat is characterized by relatively short vegetation that is primarily deciduous, with small succulent or leathery leaves. Many of the species found in dry forests are also found in dry coastal forests. A few winter migrants including yellow-rumped and yellow-throated warblers (*Setophaga coronata* and *Setophaga dominica*) prefer dry coastal forest habitat (*Nytch et al. 2015*).

[15] An epiphytic plant lives on, or is attached to, another plant (such as a tree).

Forested coastal wetlands, including mangrove swamps, occur in small patches around Puerto Rico. Within mangrove swamps the endangered yellow-shouldered blackbird, the yellow "golden" warbler (*Setophaga petechial*), white-crowned pigeon, clapper rail (*Rallus crepitans*), and the northern waterthrush (*Parkesia noveboracensis*) are all high priority species. Mangrove swamps are important foraging and nesting habitats for wading birds. Herons and egrets are the most important terrestrial predator in the mangrove swamp ecosystem (*Miranda and Collazo 1997*).

Grassland and Shrub Habitats

Grasslands and shrub habitats became common throughout Puerto Rico as a result of human activities and include old agricultural fields, sugar cane lands, and pastured meadows among others. Dry grasslands peppered with woody shrub species make up the majority of this habitat, though seasonally flooded wetlands can also be found along riparian systems and coastal zones (*Gould et al. 2013*). Relatively few native bird species are considered associated with grassland shrub habitat, of which the grasshopper sparrow (*Ammodramus savannarum*) and short-eared owl (*Asio flammeus*) are allied exclusively with them. The Antillean nighthawk (*Chordeiles gundlachii*) and Caribbean martin (*Progne dominicensis*) use grasslands and shrubs for feeding and/or breeding purposes. Grasslands and shrub habitats harbor many of the introduced exotic species in the region, particularly finches.

Marshes and Open Water Habitats

This habitat category includes lakes, fresh, brackish, and saltwater lagoons, salt flats and mudflats, water reservoirs, and the permanently marshy vegetation surrounding them. Wetland habitats are essential for the life history of rails, their allies, and other waterfowl throughout the Caribbean. Yellow-crowned night herons (*Nyctanassa violacea*), little blue herons (*Egretta caerulea*), tricolored herons (*Egretta tricolor*), and snowy egrets (*Egretta thula*) are common, permanent residents. Important short-legged congregatory shorebirds include the semipalmated sandpiper (*Calidris pusilla*) and the stilt sandpiper (*Calidris himantopus*). Important native waterfowl species utilizing marshes and open water habitats include West Indian whistling-duck (*Dendrocygna arborea*), Caribbean coot (*Fulica caribaea*), white-cheeked pintail (*Anas bahamensis*) and masked duck (*Nomonyx dominicus*). This habitat is also home to popularly hunted migratory waterfowl species including blue-winged teal (*Anas discors*), green-winged teal (*Anas carolinensis*), northern pintail (*Anas acuta*), mallard (*Anas platyrhynchos*), ring-necked duck (*Aythya collaris*), hooded merganser (*Lophodytes cucullatus*), lesser scaup (*Aythya affinis*), and northern shoveler (*Anas clypeata*).

Beaches, Islets, Cliffs, and Riparian Barrens

Bare beaches and non-vegetated riparian areas, rocky shores, rock crevices on cliffs, volcanic rocks and cays, and cave entrances by the sea provide key sites for roosting, foraging, staging, or breeding of shorebirds and colonial seabirds. Puerto Rico and its adjacent islands are inhabited by 16 species of breeding seabirds, five of which are residents throughout the year (*Saliva 2009*). Among the highest priority species, boobies (masked, red-footed, and brown [*Sula dactylatra*, *S. sula*, and *S. leucogaster*]), Audubon's shearwaters (*Puffinus lherminieri*), white-tailed tropicbirds (*Phaethon lepturus*), magnificent frigatebirds (*Fregata magnificens*), brown pelicans (*Pelecanus occidentalis*), and roseate terns (*Sterna dougallii*) breed colonially in select areas throughout Puerto Rico. Several other species of local conservation concern, such as the red-billed tropicbird (*Phaethon aethereus*), bridled tern (*Onychoprion anaethetus*), and brown noddy (*Anous stolidus*) also use this habitat type for breeding.

Urban Forest

Urban forests occur in small patches, scattered amongst human developments and other forested habitats, and span a wide range of soil, moisture and temperature conditions. These forest patches serve as vegetative oases, with a variety of ornamental, fruit, and shade trees that have great value as a wildlife refuge for native species, especially birds (*Miller and Lugo 2009*). Anthropogenic urban habitats in the region have also facilitated the establishment of many exotic bird species including, among others, at least 11 species of parrots and 14 species of sparrows and finches.

Important Habitat Areas

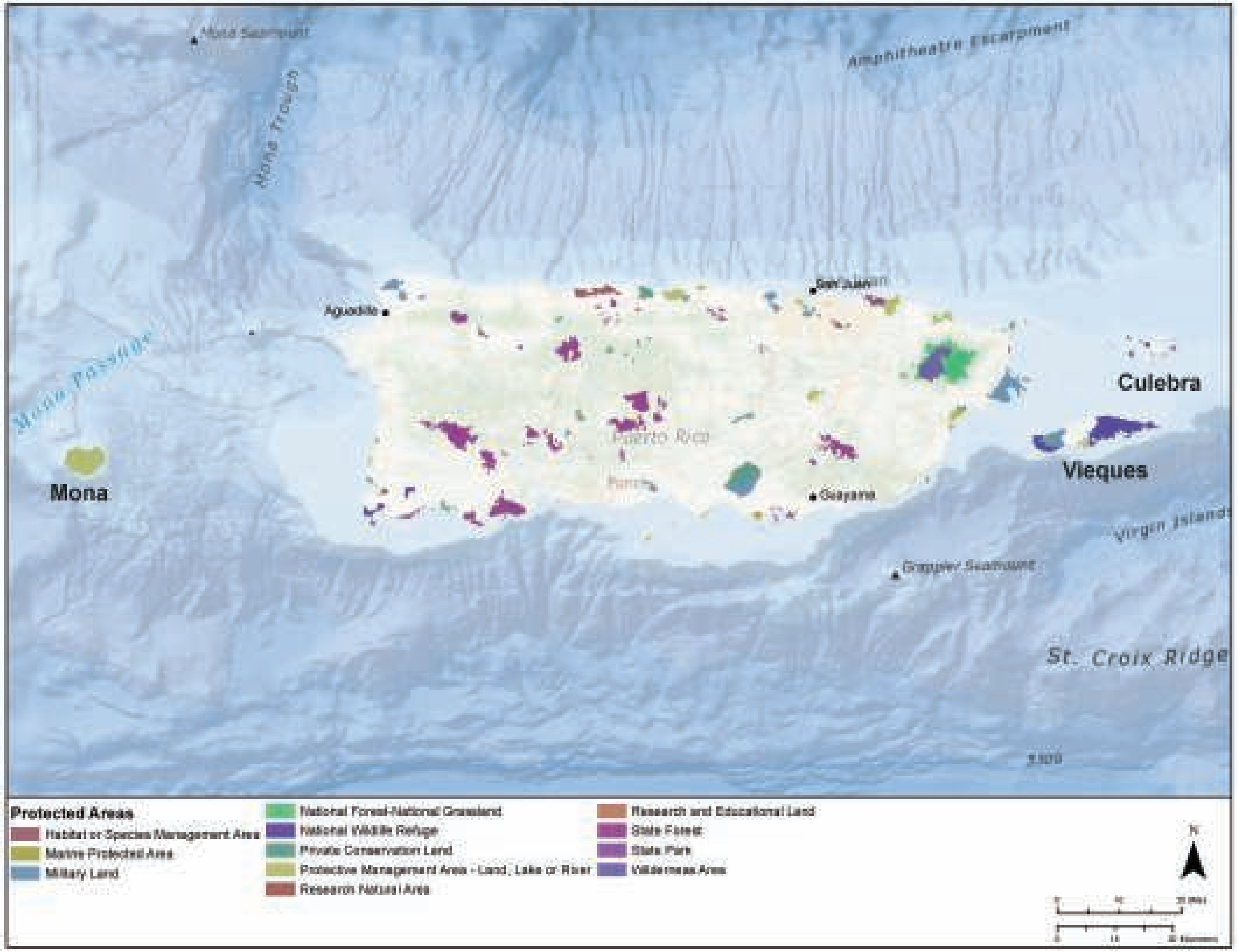
Important habitats for conservation have been identified by The Nature Conservancy (Ecoregional Plan for Puerto Rico) and the DNER through the Natural Heritage Program and the Critical Wildlife Areas Initiative. These include National Monuments, National Parks, Reserves and Sanctuaries, National Wildlife Refuges, and numerous stewardship areas (see Figure 8.1.6.4-2).

The Cabo Rojo Salt Flats (part of the Cabo Rojo National Wildlife Refuge) is one of the most important areas in the region; over 20,000 shorebirds (including Neotropical migrants) congregate there on an annual basis (*BirdLife International 2008*). The Jobos Bay Natural Reserve protects Puerto Rico's second largest estuarine system and is home to several endangered species including the West Indian manatee and sea turtles.

The Mona Passage area is an important wintering ground for humpback whales, and Mona Island is an important nesting site and juvenile grazing area for the hawksbill turtle (*Joglar et al. 2007*).

The USFWS and USFS recognize Puerto Rican karst as important habitat covering more than one third of the island's territory. It is divided into two major regions: the northern karst, which is located primarily in the subtropical moist forest, and the southern karst located primarily in the sub-tropical dry forest (*USFWS Undated; Lugo et al. 2001*). The karst region harbors the richest biodiversity in Puerto Rico with more than 1,300 species of plants and animals including 30 federally listed threatened and endangered species (*USFWS Undated*). More than 75 species of Neotropical migratory birds use the karst as wintering habitat (*USFWS Undated*).

The Guánica Commonwealth Forest in Puerto Rico has been declared a Biosphere Reserve by the United Nations and noted as one of the best extant examples of subtropical dry forest in the world (*Nytch et al. 2015*).



Source: USGS GAP 2012

Figure 8.1.6.4-2: Protected Areas in Puerto Rico

Threats and Stressors

The Puerto Rico CWCS identified major threats to Puerto Rico's wildlife resources as habitat loss, poaching and over-exploitation, and invasive exotic species (*García et al. 2005*).

Freshwater marshes and forest wetlands were reduced due to crop production and deforestation as a result of the growing population of Puerto Rico (*García et al. 2005*). Threats to important mangrove forests and other coastal wetlands include draining, dredging, siltation, eutrophication,[16] dumping, tourism impact, housing, and road construction (*García et al. 2005*). Forest clearing and fires have contributed to habitat loss in the tropical dry forest region (*The Nature Conservancy 2015*).

Coral reefs are threatened by developments associated with climate change such as sea level rise, coastal erosion, ocean acidification, coral diseases and bleaching and increased sea-surface temperature and associated impacts to organisms within coral reef ecosystems (*NOAA CRCP 2010*).

Habitat loss and fragmentation increases the threat that hurricanes and tropical storms pose to animals in Puerto Rico (*Gould et al. 2008*). For example, about half of the wild parrot population disappeared when Hurricane Hugo struck the Luquillo forest in 1989 (*Vilella and García 1995*).

Introduction and/or spread of invasive plants and unwanted exotic and native organisms into ecosystems can increase wildlife predation, competition, and reduced fitness or cause loss of wildlife habitat. Significant numbers of wildlife are lost each year to relatively small non-native rat, cat, and mongoose populations (*García et al. 2005*). The cumulative impacts associated with these increasing wildlife loses are large for small islands, such as Puerto Rico, that have both smaller resident wildlife populations and lower species diversity compared to mainland wildlife populations.

For more information about threats and stressors to wildlife in Puerto Rico, please see the Environmental Consequences section (Section 8.2.6.4).

[16] Eutrophication is a process where waterbodies receive excess nutrients that stimulate excessive plant growth.

8.1.6.5. Fisheries and Aquatic Habitats

Introduction

This section discusses fisheries resources of Puerto Rico. Information is presented regarding fisheries features and characteristics that would be potentially sensitive to impacts from deployment and operation of the Proposed Action.

Species included in this section include freshwater and marine species of fish and shellfish occurring in Puerto Rico and in Puerto Rico's offshore environment. Fish species and habitat in Puerto Rico are generally discussed in this section. For more information about water, see Section 8.1.4, Water Resources. Fisheries are defined as the human activities involved in harvesting[1] fish or shellfish, or a group of fish species that share the same habitat (*NOAA 2015a*). The types of fisheries in Puerto Rico include commercial,[2] subsistence,[3] and recreational.[4] For more information on subsistence use and threatened and endangered species of fish, see Section 8.1.9, Socioeconomics, and Section 8.1.6.6, Threatened and Endangered Species and Species of Conservation Concern, respectively.

Specific Regulatory Considerations

The Department of Natural and Environmental Resources of Puerto Rico (DNER), the Caribbean Fisheries Management Council (CFMC), and the National Oceanographic and Atmospheric Administration's (NOAA) Southeast Regional Office are the primary managing agencies of Puerto Rico's fisheries. In federal waters, the CFMC develops management measures through fishery management plans. In Commonwealth-managed waters (inside of the exclusive economic zone), the DNER and CFMC have jurisdiction.

NOAA's Atlantic Highly Migratory Species Management Division manages several species in the United States (U.S.) waters in the Atlantic and the Gulf of Mexico that are considered highly migratory species;[5] these include tuna, sharks, swordfish, and billfish (*NOAA 2015b*). A federal permit is required to fish for these species.

Commercial and recreational fishermen in Puerto Rico are required to have a current fishing license (*DNER 2004*). Guidance on compliance with the Puerto Rico fisheries regulations can be found at the CFMC (*2015*) website.

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[1] Harvesting is the act or process to take or kill wildlife for food, sport, or population control.

[2] Commercial fishing is the whole process of catching and marketing fish and shellfish for sale (*NOAA 2015a*).

[3] The catch is shared and consumed directly by the families and kin of the fishermen, rather than being sold (*NOAA 2015a*).

[4] The catch is for personal use, pleasure, or competition (*NOAA 2015a*).

[5] Highly migratory species are pelagic or open water species that have a wide geographic distribution, both inside and outside countries' 200-mile zones, and that undertake migrations of significant but variable distances across oceans for feeding or reproduction (*PFMC 2015*).

Environmental Setting

Because of their similar geographic position, climatic condition, and coastal habitats, Puerto Rico and the U.S. Virgin Islands, known collectively as the U.S. Caribbean region, have similar vegetation and fish species (*NOAA Undated*).

Saltwater Marshes

Seagrass habitats are common in the coastal saltwater environment around Puerto Rico. Three dominant seagrass species in the U.S. Caribbean include: turtle grass (*Thalassia testudinum*), shoal grass (*Halodule wrightii*), and manatee grass (*Syringodium filiforme*) (*NOAA Undated*). These grasses prefer shallow areas with clear water, which allows light penetration. Seagrass habitats are important for fish species as they provide food, cover from predators, and nursery areas for juveniles. Some species eat the grasses directly: the scrawled filefish (*Aluterus scriptus*), sharpnose puffer (*Canthigaster rostrate*), keeled needlefish (*Platybelone argalus*), and ocean surgeon (*Acanthurus bahianus*) (*NOAA Undated*). Some predator species (e.g., snappers) utilize the seagrasses to prey on juvenile and small fish species (*NOAA Undated*). Some commonly found fish species in seagrass beds include blackear wrasse (*Halichoeres poeyi*), the endangered Nassau grouper (*Epinephelus striatus*), peacock flounder (*Bothus lunatus*), queen conch (*Strombus gigas*), scorpionfish (*Scorpaenopsis grandicornis*), sergeant major (*Abudefduf saxatilis*), spiny lobster (*Panulirus argus*), and spotted goatfish (*Pseudupeneus maculatus*) (*NOAA Undated*).

Mangroves

In the U.S. Caribbean, mangrove forests occur in the intertidal zones that border the coastline, lagoons, and canals; in addition, mangroves form large forests in river deltas. Four common mangrove species dominate: red mangrove (*Rhizophora mangle*), black mangrove (*Avicennia germinans*), white mangrove (*Laguncularia racemose*), and button mangrove (*Conocarpus erectus*) (*NOAA Undated*). Mangroves are flooded at least twice each day at high tides. Many different species of fish use mangroves for the same reasons they use seagrass beds; intricate root systems, fallen branches, wood, and leaves make these areas attractive to fishes and other organisms seeking food and shelter from predators (*NOAA Undated*). Some commonly found fish species in mangroves include anchovy (*Cetengraulis edentulus*), gray snapper (*Lutjanus griseus*), great barracuda (*Sphyraena barracuda*), mangrove oyster (*Crassostrea rhizophorae*), mutton snapper (*Lutjanus analis*), Irish pompano (*Diapterus auratus*), common snook (*Centropomus undecimalis*), and tarpon (*Megalops atlanticus*) (*NOAA Undated*).

Freshwater Environment

Freshwater habitats in Puerto Rico include rivers, lakes, lagoons, streams, and ponds. Freshwater marshes have diverse vegetation consisting of grasses, sedges, rushes, and broad-leaved aquatic plants (e.g., swamp fern [*Blechnum serrulatum*], sawgrass [*Cladium jamaicense*], giant sedge [*Carex gigantean*], water grass [*Commelina* spp.], hibiscus [*Hibiscus*], arrowhead [*Sagittaria* spp.], and cattail [*Typha* spp.]) (*NOAA Undated*). Aquatic freshwater environments are dominated by vegetation such as water lily (*Nymphaea* spp.), alligator weed (*Alternanthera* *philoxeroides*), naiad (*Najas* spp.), fanwort (*Cabomba caroliniana*), and water hyacinth (*Eichhornia crassipes*) (*NOAA Undated*). Some commonly found fish species in freshwater habitats include American eel (*Anguilla rostrate*), bigmouth sleeper (*Gobiomorus dormitory*), fat sleeper (*Dormitator maculatus*), mosquitofish (*Gambusia affinis*), mountain mullet (*Agonostomus monticola*), river crab (*Epilobocera sinuatifrons*), river prawn (*Macrobrachium* spp.), swordtail (*Xiphophorus hellerii*), and tilapia (*Oreochromis mossambicus*) (*NOAA Undated*).

Coral Reefs and Marine Environment

The habitat characteristics of coral reefs and the marine environment were described by the CFMC (*1998*):

> "About eighty different bottom types are found around Puerto Rico, which vary in depth and consist of combinations of gravel, rock, sand, mud, and clay. The bottom types greatly influence which organisms are found in each habitat. Many of the hard bottom areas consist of coral and non-coral reefs. Nearshore, coral reefs are common. Inshore of the reefs, the dominant habitats are seagrasses and tidal wetlands, primarily mangrove wetlands. The overlying waters form the "blood supply" of these systems and are also essential fish habitat. Acting together these coastal areas provide food, habitat, and water quality maintenance functions that support the areas' important fisheries."

Fish and shellfish species are highly diverse in the coral reefs and marine environment of Puerto Rico (*CFMC 1998*).

Fisheries Characteristics

Commercial

Commercial fisheries on Puerto Rico are regulated by the DNER (*2004*). Many fish species and species groups are vulnerable to over-harvest, particularly snapper (family Lutjanidae) and grouper (family Serranidae), due to slow growth, reproduction, and predictable spawning aggregations (*Matos-Caraballo and Agar 2011*). In response to these vulnerabilities regulations were enacted that brought major changes to the commercial fishing industry on Puerto Rico. In March 2004, Puerto Rican Regulation No. 6768 changed local fishery management by requiring licensing and landing reporting, added stringent conservation measures, income reporting requirements, season closures for several fish species, minimum size restrictions for some species, purchase permits for some species, and closures to endangered species fisheries (*Matos Caraballo and Agar 2011*). After this implementation, the number of commercial fishermen on Puerto Rico was almost halved.

Commercial fishers target conch, lobster, reef fish, tuna, and wahoo (*Acanthocybium solandri*), but their primary target in terms of weight is deep water snapper (*Etelis carbunculus*) (*Munoz et al. 2013*). Some of the other most economically valuable fisheries include spotted goatfish

(*Pseudupeneus maculatus*), gray snapper, mutton snapper, American eel, and tilapia (*NOAA Undated*).

Subsistence

Lagoons, estuaries, and streams on Puerto Rico are often utilized by community members for subsistence fishing. Subsistence fish species are caught using a variety of methods such as nets, hooks and lines, and pots. The queen conch, spiny lobster, mountain mullet, river crab, and river prawn are all important subsistence-use fish and shellfish species in Puerto Rico (*NOAA Undated*). The spiny lobster is not exported but it is consumed locally (*NOAA Undated*).

Recreational

Recreational fishing on Puerto Rico is regulated by the Department of Natural and Environmental Resources (*DNER 2004*).

Saltwater sport fishing with rods and lures for species such as marlin (family Istiophoridae), sailfish (*Istiophorus albicans*), tunas, dolphin fish (mahi-mahi) (*Coryphaena hippurus*), wahoo, snapper, barracuda (*Sphyraena* spp.), jacks, tarpon, grouper, and kingfish (*Scomberomorus cavalla*) is popular in Puerto Rico (*World Wide Fishing 2015*). Dolphin fish is the most sought-after species in marine recreational fishing (*Munoz et al. 2013*). Commonly fished freshwater game fish include such species as tarpon, snook, silver king, jacks, peacock bass (*Cichla* spp.), largemouth bass (*Micropterus salmoides*), guapote (*Parachromis* spp.), red devils (*Amphilophus labiatus*), and dolphin fish (*World Wide Fishing 2015*). A federal permit is required to fish recreationally for, retain, or possess any highly migratory species including tunas, sharks, billfish (i.e., sailfish and marlin), and swordfish (*NOAA 2015b*).

Areas of Importance

Essential fish habitat (EFH), as defined in the Magnuson-Stevens Fishery Conservation and Management Act, means those waters and substrate necessary to federally managed fish species for spawning, breeding, feeding, or growth to maturity (*CFMC 1998*). Habitats classified as mangrove estuary, seagrass bed, coral reef, algal plain, sand/mud bottom, shelf break, and overlying pelagic are considered EFH by the CFMC (*CFMC 1998*).

The Magnuson-Stevens Fishery Conservation and Management Act requires that management decisions be based on the best available information. The available information is insufficient to provide for identification of EFH for each species given the large number of species involved. For example, there are more than 1,149 species of fish and over 1,170 mollusks reported for Puerto Rico and the U.S. Virgin Islands (*CFMC 1998*). Therefore EFH was identified and described based on areas where various life stages of 17 selected managed species and the coral complex commonly occur (*CFMC 1998*). The selected species are: Nassau grouper, red hind (*Epinephelus guttatus*), coney (*Epinephelus fulvus*), yellowtail snapper (*Ocyurus chrysurus*), mutton snapper, schoolmaster (*Lutjanus apodus*), gray snapper, silk snapper (*Lutjanus vivanus*), butterfly fish (*Chaetodon striatus*), squirrel fish (*Holocentrus ascensionis*), white grunt (*Haemulon plumieri*), queen triggerfish (*Balistes vetula*), sand tilefish (*Malacanthus plumieri*), redtail parrotfish (*Sparisoma chrysopterum*), trunkfish (*Lactophrys quadricornis*), spiny lobster, and queen conch (*CFMC 1998*). Figure 8.1.6.5-1 shows mapped offshore habitat types and management areas.

According to the CFMC (*1998*):

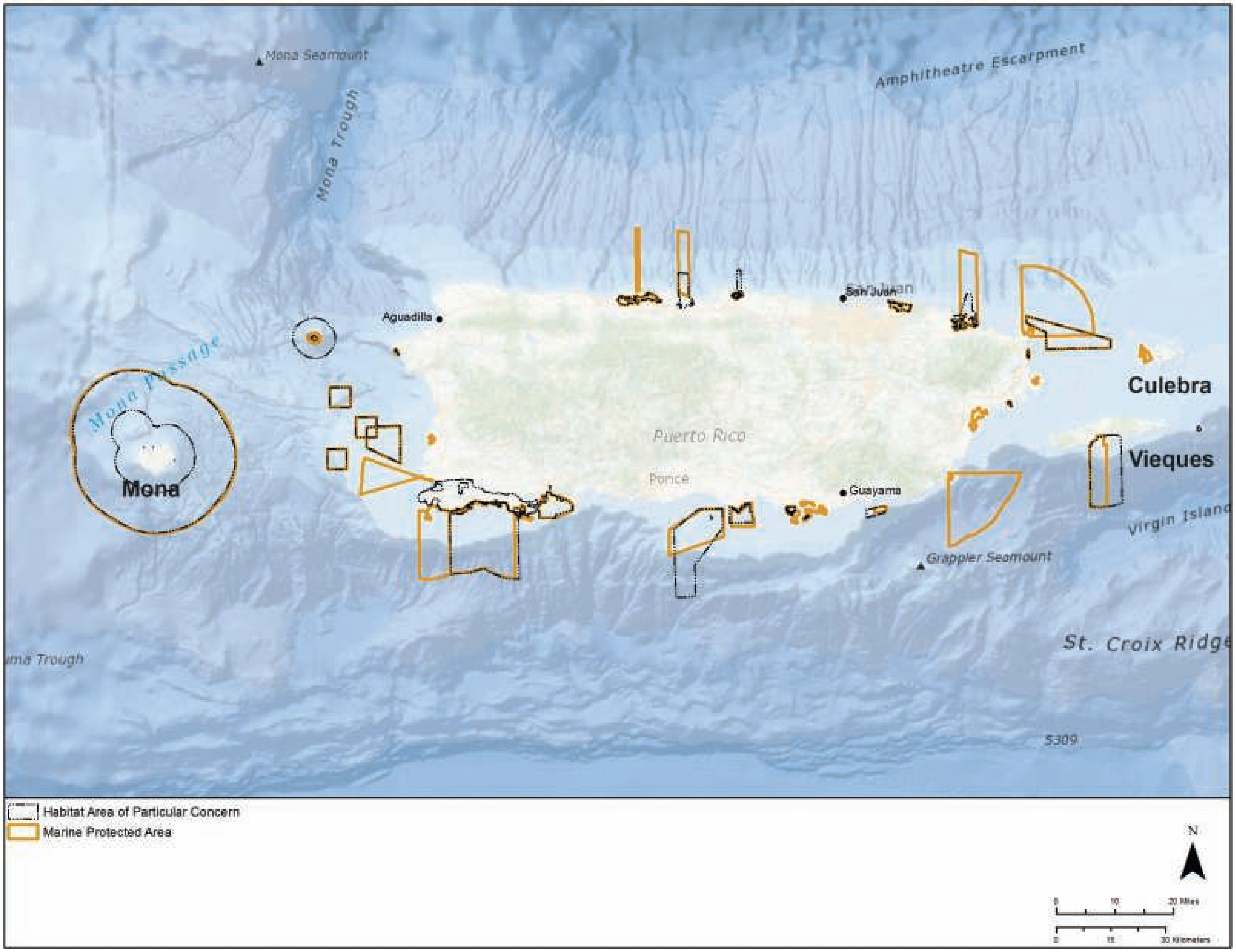
> "EFH is defined as everywhere that the managed and selected species commonly occur (see above). Because these species collectively occur in all habitats of the U.S. Caribbean, the EFH includes all waters and substrates (e.g., mud, sand, shell, rock, and associated biological communities), including coral habitats (coral reefs, coral hardbottoms, and octocoral reefs), sub-tidal vegetation (seagrass and algae) and adjacent intertidal vegetation (wetlands and mangroves). Therefore, EFH includes virtually all marine waters and substrates (mud, shell, rock, coral reefs, and associated biological communities) from the shoreline to the seaward limit of the Exclusive Economic Zone." [6]

There are many coastal protected areas in and around Puerto Rico. All of the National Wildlife Refuges (NWR) on Puerto Rico have fish habitat (Figure 8.1.6.5-1). These refuges include the Cabo Rojo NWR, Culebra NWR, Desecheo NWR, Laguna Cartagena NWR, Navassa Island NWR, and Vieques NWR (*USFWS 2015*). The Tortuguero Lagoon Reserve is the largest natural body of fresh water in Puerto Rico; this unique lagoon, which is fed by fresh water springs before flowing into the sea, is frequently utilized for subsistence and recreational fishing (*PuertoRico.com 2015*). Punta Ballena Reserve is a coastal mangrove ecosystem with United Nations Educational, Scientific, and Cultural Organization designation (*PuertoRico.com 2015*). La Cordillera Nature Reserve consists of 10 islands surrounded in coral reefs (*PuertoRico.com 2015*). Jobos Bay Reserve is a research reserve of mangroves and wetlands and hosts rare and endangered fish and wildlife (*PuertoRico.com 2015*).

Threats and Stressors

Marsh, lake, and lagoon habitat (wetlands) within the U.S. Caribbean have been reduced by more than 50 percent, mostly due to draining for agriculture, flood control projects, and urban and industrial development (*NOAA Undated*). Climate change associated with increased sea levels and changes in water temperature is also responsible for the loss and degradation of wetlands and reefs (*NOAA Undated*). Coral bleaching results from rising water levels and higher water temperatures (*NOAA Undated*). Human activities such as deforestation, urban development, industry, agriculture, damming and diverting rivers, and uncontrolled tourist activities (e.g., diving and boating) are some of the most devastating activities to coral reefs and fish habitat in Puerto Rico (*NOAA Undated*). Introduced species (e.g., mosquitofish, tilapia, and Indo-Pacific lionfish) compete with native species for food and territories and alter the balance of the aquatic ecosystem (*NOAA Undated; UVI 2009*).

[6] The U.S. Exclusive Economic Zone is a 200-mile ocean boundary around the coastline of U.S. states and territories in which the U.S. asserts exclusive commercial fishing rights.



Sources: NOAA and USDOI 2014; NOAA 2010

Figure 8.1.6.5-1: Puerto Rico Marine Protected Areas and Habitats of Particular Concern

Major sources of pollution into the marine environment around Puerto Rico include agriculture, urbanization, silviculture, industrial discharges, municipal wastewater discharges, urban storm water discharges, vessel wastewater discharges, thermal effluents from electrical power generation facilities, hydrocarbon pollution, toxins in cleaning materials, chemical contaminant spills, air emissions, ocean dumping, salinity, turbidity, and recreational boating impacts (*CFMC 1998*).

Overfishing is when fish are harvested at a rate faster than they can reproduce, a potentially devastating problem for fisheries worldwide (*Monterey Bay Aquarium 2015*). The issue begins with fishermen targeting the largest fish in the population, for the greatest economic value. Then when the largest fish are depleted, they target the next size down, and so on. Additionally, the larger fish are generally the ones that reproduce; when the larger fish are gone, the population cannot sustain itself. Some examples of fish in the U.S. Caribbean that are at risk of overfishing include the mutton snapper, common snook, and American eels (*NOAA Undated*). The endangered Nassau grouper has been so heavily targeted by fishermen that the species' spawning aggregations have been eliminated (*UVI 2009*).

Bycatch, or the unintentional capture/injury/entanglement of unwanted species during commercial fishing, is a major issue in fisheries management. NOAA (*2011*) describes the effects and importance of managing non-target species bycatch:

> "Bycatch costs fishermen time and money, harms endangered and threatened species, affects marine and coastal ecosystems, and makes it more difficult for scientists to measure the effect of fishing on the stock's population, and for managers to set sustainable levels for fishing. Preventing and reducing bycatch is an important part of ensuring sustainable living marine resources and coastal communities. The 2006 reauthorization of the Magnuson Stevens Act, the nation's principal law for living marine resources, made bycatch reduction a priority, leading NOAA to establish a bycatch reduction program to develop technological devices and other conservation engineering solutions."

There are also naturally occurring threats to fish habitat, such as storm and hurricane action which can devastate coastal ecosystems by uprooting seagrasses, coral reefs, and mangroves (*NOAA Undated*). Additionally, sea urchins' and manatees' excessive grazing can severely disturb seagrass communities (*NOAA Undated*).

8.1.6.6. Threatened and Endangered Species and Species of Conservation Concern

Introduction

The threatened and endangered species analysis in this Final Programmatic Environmental Impact Statement considers plant and animal species that are federally listed as threatened (likely to become endangered), endangered (at risk for extinction), candidate,[1] proposed,[2] or species of concern (species in need of conservation); species listed by the United States (U.S.) Forest Service (Forest Service) as sensitive; and species that are territory-listed as critically endangered, endangered, threatened, or vulnerable. This analysis considers species that are known to occur in Puerto Rico for all or part of their life cycle.[3]

Specific Regulatory Considerations

Federal Regulations

Endangered Species Act

The Endangered Species Act (ESA) is administered by the U.S. Fish and Wildlife Service (USFWS) and National Marine Fisheries Service (NMFS) (see Section 1.8.3, Endangered Species Act). With some exceptions, Section 9 of the ESA prohibits unauthorized *take*[4] of any fish or wildlife species listed as endangered or threatened under the ESA. Subject to specified terms and conditions, Section 10 of the ESA allows for the incidental take of listed species by non-federal entities otherwise prohibited by Section 9. Pursuant to Section 10, an Incidental Take Permit[5] is issued through adoption of an USFWS-approved Habitat Conservation Plan,[6] which demonstrates that take has been avoided, minimized, and mitigated (reduced severity) to the maximum extent practicable.

Section 7(a)(2) of the ESA states that each federal agency shall ensure that any action it authorizes, funds, or carries out is not likely to jeopardize the continued existence of listed species or result in destruction or adverse modification of designated critical habitat. A federal action "means all activities or programs of any kind authorized, funded, or carried out, in whole or in part, by Federal agencies in the United States or upon the high seas" (*50 CFR § 402.2*).

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[1] Candidate species are species officially nominated for listing as threatened or endangered, according to the ESA.

[2] Proposed species are those that have been proposed for listing as threatened or endangered in the *Federal Register* after the completion of a status review and consideration of other protective conservation measures.

[3] Life cycle is defined as the continuous sequence of an organism's development.

[4] *Take* is defined differently by various federal and state regulations, but the most commonly accepted definition is that of the U.S. ESA that defines *take* as "to harass, harm, pursue, hunt, shoot, wound, trap, capture, collect or attempt to engage in any such conduct."

[5] An Incidental Take Permit is issued under Section 10 of the ESA to private parties undertaking otherwise lawful projects that might result in the *take* of an endangered or threatened species (*USFWS 2015a*).

[6] A plan that outlines mitigation measures to enhance, maintain, and protect habitats of a particular species. The Plan is developed to help reduce impacts.

Actions of federal agencies that do not jeopardize the continued existence of listed species or result in destruction or adverse modification of their designated critical habitat, but that could result in a take, must be addressed by consulting with applicable resource agencies under Section 7. The Proposed Action is subject to the ESA because it is a proposed federal undertaking.

Forest Service and Bureau of Land Management Sensitive Species Requirements

The Forest Service Southern Region (Region 8) has one national forest in Puerto Rico: the El Yunque National Forest. The Forest Service is required under the National Forest Management Act (*36 CFR § 219.19*) to manage sensitive species populations and consider the potential effects of proposed activities within Forest Service lands on these species to ensure that activities do not contribute to trends leading to the listing of these species under the ESA. The Forest Service does not maintain a sensitive species list that is specific to Puerto Rico or the El Yunque National Forest.

Territory Regulations

Puerto Rico Law 241 establishes the territory's legal framework related to endangered species, and Regulation 6766 provides the regulations and lists those species protected under the law within the territory. Under Law 241, the Puerto Rico Department of Natural and Environmental Resources is responsible for determining and maintaining a list of threatened and endangered species in Puerto Rico. Puerto Rico codified its list of species of concern in *Regulation 6766* (*PRDS 2004*) and incorporated it into its Comprehensive Wildlife Conservation Strategy, which assesses the needs of species with conservation concerns and prioritizes conservation and other actions to maintain or restore populations of these species. This list includes 132 terrestrial, freshwater, and marine plant and animal species (*PRDNER 2005*). The strategy is currently being updated.

Species Overview

Federally and Territory-listed Species

There are 95 federally and territory-listed species in Puerto Rico. Of the 95 federally and territory-listed species, 50 are plants, 8 are birds, 6 are marine mammals, 4 are marine reptiles (sea turtles), 7 are terrestrial reptiles, 6 are amphibians, 4 are fish, and 10 are marine invertebrates (*NOAA 2016*; *USFWS 2016a*; *USFWS 2015b; NMFS 2015;PRDNER 2005*). There are no Federal Species of Concern. Table 8.1.6.6-1 lists the federally and territory-listed species and summarizes their habitat preferences, geographic distribution, population status, and occurrence in Puerto Rico.

Table 8.1.6.6-1: Federal- and Territory-listed Threatened and Endangered Species Known to Occur in Puerto Rico

Common Name and Scientific Name	Listing Status[a]	Type of Habitat (Terrestrial, Marine, or Freshwater)	General Habitat Description	Geographic Range	Population Status (Stable, Declining, Increasing, Unknown)	Occurrence in Puerto Rico (B=Breeding, Y= Year Round Resident, W=Wintering, M-Migratory)
Plants (50)						
Monte Guilarte hollyfern (*Polystichum calderonense*)	FE, TCE	Terrestrial	Epiphytic fern found growing on moist, shaded, non-calcareous rock ledges on mountain tops of volcanic origin	Found only in (i.e., endemic to) Puerto Rico and limited to two locations including the summit of La Silla de Calderón in Monte Guilarte Commonwealth Forest, and in Cerrote Peñuelas in the municipality of Peñuelas	Declining	Y
Elfin tree fern (*Cyathea dryopteroides*)	FE, TE	Terrestrial	Known only to grow in the highest peaks of the Cordillera Central Mountain Range, above 2700 feet within “elfin forests” that contain trees with stunted growth due to environmental conditions; typically found on the more rounded mountaintops	Endemic to Puerto Rico and limited to populations on the peaks of Monte Jayuya, Cerro Rosa in Ciales, and Monte Guilarte	Unknown; observations of individuals at varied life stages suggest an improving population	Y
No Common Name (*Thelypteris verecunda*)	FE, TCE	Terrestrial	Found in wet, shaded limestone areas within semi-evergreen subtropical forests in elevations of around 650 feet	Endemic to Puerto Rico and limited to three locations including Charcas Barrio in Quebradillas, Barrio Bayaney in Hatillo, and Barrio Cidral in San Sebastián	Unknown	Y

Common Name and Scientific Name	**Listing Status[a]**	**Type of Habitat (Terrestrial, Marine, or Freshwater)**	**General Habitat Description**	**Geographic Range**	**Population Status (Stable, Declining, Increasing, Unknown)**	**Occurrence in Puerto Rico (B=Breeding, Y= Year Round Resident, W=Wintering, M-Migratory)**
No Common Name (*Thelypteris inabonensis*)	FE, TCE	Terrestrial	Lower montane wet forest, at elevations of 1,120 to 1,250 meters; locally grows along stream banks and in deeply shaded mossy forest	Endemic to Puerto Rico and limited to two locations in the Toro Negro Commonwealth Forest including the headwaters of Río Inabón in Ponce and at Cerro Rosa in Ciales	Unknown	Y
No Common Name (*Thelypteris yaucoensis*)	FE, TCE	Terrestrial	Grows in steep, shaded, rocky banks and ledges at high elevations, ranging from 2780 to 3940 feet in altitude	Endemic to Puerto Rico and limited to three locations including Rubias Ward and Pico Rodadero in Yauco and Los Tres Picachos in Ciales, all within private property	Unknown	Y
No Common Name (*Adiantum vivesii*)	FE, TCE	Terrestrial	Locally occurs in a deeply shaded hollow at the base of a limestone hill	Endemic to Puerto Rico where it is known from a single population of about 1000 individuals on private property near Quebradillas in northern Puerto Rico	Unknown	Y
No Common Name (*Tectaria estremerana*)	FE, TCE	Terrestrial	A woody fern found within karst	Endemic to Puerto Rico and limited to three locations: near the Arecibo Radio Telescope, within Río Abajo Commonwealth Forest, and in the Abajo Ward in Municipality of Florida	Unknown	Y
No Common Name (*Elaphoglossum serpens*)	FE, TCE	Terrestrial	An epiphytic fern found in montane forest containing trees with stunted growth (elfin forest); it has been found on the mossy trunks of only six trees	Endemic to Puerto Rico where it is known from a single population on Cerro de Punta in Jayuya, within Toro Negro Commonwealth Forest	Declining	Y

Common Name and Scientific Name	Listing Status[a]	Type of Habitat (Terrestrial, Marine, or Freshwater)	General Habitat Description	Geographic Range	Population Status (Stable, Declining, Increasing, Unknown)	Occurrence in Puerto Rico (B=Breeding, Y= Year Round Resident, W=Wintering, M-Migratory)
Bariaco (*Trichilia triacantha*)	FE, TCE	Terrestrial	Found in deciduous and evergreen dry forests on soils derived from limestone, often near streams and at elevations below 100 meters	Endemic to Puerto Rico and limited to an estimated 40 individuals in the Guánica Commonwealth Forest	Unknown	Y
Beautiful goetzea (*Goetzea elegans*)	FE, TE	Terrestrial	Edge of forested, semi-evergreen hills below 660 feet	Endemic to Puerto Rico and limited to the northwestern portion of the island in the area of Quebradillas and Isabela; majority of individuals are located on private land.	Unknown	Y
Capa rosa (*Callicarpa ampla*)	FE, TCE	Terrestrial	Evergreen forest found at elevations greater than 600 meters on well vegetated slopes	Endemic to Puerto Rico and limited to one population in the Luquillo Mountains in the El Yunque National Forest	Unknown	Y
Chupacallos (*Pleodendron macranthum*)	FE, TCE	Terrestrial	Subtropical wet and lower montane wet forests, found in semi-open areas in limestone slopes	Endemic to Puerto Rico and limited to five populations in El Yunque and Río Abajo commonwealth forests	Unknown	Y
Cobana negra (*Stahlia monosperma*)	FT	Terrestrial	Seasonally flooded brackish wetlands in association with mangroves and in coastal forest; they are restricted to drier, elevated microclimates at the edge of lagoons and mangroves	Native to three Caribbean islands: Puerto Rico, Dominican Republic, and the U.S. Virgin Islands; in Puerto Rico it is known to exist in Cabo Rojo, Río Grande, and Vieques with new populations reported in Guayanilla, Cabo Rojo and Lajas (Sierra Bermeja)	Increasing	Y

Common Name and Scientific Name	Listing Status[a]	Type of Habitat (Terrestrial, Marine, or Freshwater)	General Habitat Description	Geographic Range	Population Status (Stable, Declining, Increasing, Unknown)	Occurrence in Puerto Rico (B=Breeding, Y= Year Round Resident, W=Wintering, M-Migratory)
Cook's holly (*Ilex cookii*)	FE, TCE	Terrestrial	Documented populations occurred at elevations from 3,950 to 4,300 feet, within the lower montane wet forest	Endemic to Puerto Rico and historically known along the ridgetops of monte Jayuya and Cerro Punta. The species has not been sighted since 1970	Unknown	Y
Erubia (*Solanum drymophilum*)	FE, TE	Terrestrial	Evergreen forests at elevations from 1000 to 3000 feet	Endemic to Puerto Rico and limited to four sites in Piedras del Collado, Florida (two sites) and Arecibo	Unknown	Y
Higo chumbo (*Harrisia portoricensis*)	FT, TV	Terrestrial	Cactus forest but also occurs in other types of vegetation, including plateau forest, depression forest, cliffside forest, and the plateau shrub forest; suitable habitat for germination and establishment occur in shaded areas beneath the canopy of native shrubs	Endemic to Puerto Rico; known on three smaller islands off the coast of the main island (Mona Island, Monito Island, and Desecheo Island); efforts to introduce the species to the main island are underway, with limited success	Stable	Y
Higuero de Sierra (*Crescentia portoricensis*)	FE, TCE	Terrestrial	Found on serpentine-derived soils at elevations ranging from 250-800 meters in subtropical moist and wet forests; locally found along the banks of streams	Endemic to two areas in Puerto Rico; in the Maricao Commonwealth Forest and the Susua Commonwealth Forest	Unknown	Y
No Common Name (*Chamaecrista glandulosa* var. *Mirabilis*)	FE, TE	Terrestrial	Occurs on the north central coastal plain, limited to white silica sands	Endemic to Puerto Rico; found on the northern coast, in Tortuguero and Dorado	Unknown	Y

Common Name and Scientific Name	**Listing Status[a]**	**Type of Habitat (Terrestrial, Marine, or Freshwater)**	**General Habitat Description**	**Geographic Range**	**Population Status (Stable, Declining, Increasing, Unknown)**	**Occurrence in Puerto Rico (B=Breeding, Y= Year Round Resident, W=Wintering, M-Migratory)**
Tropical lilythorn (*Catesbaea melanocarpa*)	FE	Terrestrial	Subtropical dry forest to dry thicket scrub	Native to five Caribbean islands including Puerto Rico, St. Croix, Barbuda, Antigua, and one island in Guadeloupe; in Puerto Rico, one population was recorded in Penones de Melones in Cabo Rojo, but recent reports indicate the population may be extirpated (locally extinct)	Decreasing	Y
No Common Name (*Cranichis ricartii*)	FE, TCE	Terrestrial	Moist serpentine scrub forests of montane ridges at elevations above 680 meters	Native to Cuba, Dominican Republic, Guadeloupe and Puerto Rico; it is found at only three locations within the Maricao Commonwealth Forest in Puerto Rico	Unknown	Y
No Common Name (*Daphnopsis helleriana*)	FE, TCE	Terrestrial	Commonwealth forests within the northern karst limits (limestone hills)	Endemic to northern Puerto Rico (Dorado, Toa Baja, Isabela/Quebradillas, Arecibo/Utuado, and Vega Baja)	Stable	Y
No Common Name (*Auerodendron pauciflorum*)	FE, TCE	Terrestrial	Subtropical moist forest, limited to limestone cliffs	Endemic to Puerto Rico; known from 21 individuals in two privately owned areas in the Coto Ward, municipality of Isabela	Unknown	Y
Thomas' Lidflower (*Calyptranthes thomasiana*)	FE, TCE	Terrestrial	Moist forests and may extend into dry forests at altitudes between 900-1,300 feet above mean sea level	Native to three Caribbean islands: Puerto Rico, British Virgin Islands, and the U.S. Virgin Islands; recent studies indicate the species no longer exists in Puerto Rico	Unknown	Y

Common Name and Scientific Name	Listing Status[a]	Type of Habitat (Terrestrial, Marine, or Freshwater)	General Habitat Description	Geographic Range	Population Status (Stable, Declining, Increasing, Unknown)	Occurrence in Puerto Rico (B=Breeding, Y= Year Round Resident, W=Wintering, M-Migratory)
No Common Name (*Cordia bellonis*)	FE, TE	Terrestrial	Mountain slopes, serpentine hills, and in limestone soil. Requires open, sunny areas	Endemic to Puerto Rico; known to be found in Maricao, Susúa and Río Abajo State Forests, as well as the municipalities of Utuado and Ciales	Declining	Y
No Common Name (*Aristida chaseae*)	FE, TE	Terrestrial	Dry, open grasslands and rocky, exposed upper mountain slopes	Endemic to southwestern Puerto Rico in the Cabo Rojo National Wildlife Refuge, Peñones de Melones and the Cerro mariquita	Increasing	Y
No Common Name (*Vernonia proctorii*)	FE, TCE	Terrestrial	Open, rocky slopes	Endemic to southwestern Puerto Rico, with one known location on Cerro Mariquita in Sierra Bermeja in the municipality of Cabo Rojo	Increasing	Y
No Common Name (*Ternstroemia subsessilis*)	FE, TCE	Terrestrial	Wet montane forest	Endemic to Puerto Rico; found primarily in the Caribbean (a total of three sub-populations) and in Carlos Rivera	Unknown	Y
No Common Name (*Myrcia paganii*)	FE, TCE	Terrestrial	Seasonal evergreen or semi-evergreen forest underlain by limestone	Endemic to north and northwestern Puerto Rico with only three known populations, accounting for eight individuals in total	Unknown	Y
No Common Name (*Schoepfia arenaria*)	FT, TE	Terrestrial	Low-elevation evergreen and semi-evergreen forests at elevations from 450 to 1,000 feet above sea level	Endemic to the limestone hills of northern Puerto Rico in Isabela and Pinones	Unknown	Y
No Common Name (*Lepanthes eltoroensis*)	FE, TCE	Terrestrial	Upper elevation of montane forests, however little information is known regarding habitat preference	Endemic to the Luquillo Mountains of Puerto Rico, within the El Yunque National Forest	Unknown	Y

Common Name and Scientific Name	Listing Status[a]	Type of Habitat (Terrestrial, Marine, or Freshwater)	General Habitat Description	Geographic Range	Population Status (Stable, Declining, Increasing, Unknown)	Occurrence in Puerto Rico (B=Breeding, Y= Year Round Resident, W=Wintering, M-Migratory)
No Common Name (*Ilex sintenisii*)	FE, TE	Terrestrial	"Elfin forests" containing short, small and dense trees on mountain summits	Endemic to the Toro Negro State Forest in the Luquillo Mountains of Puerto Rico where only three populations are known at Rio Blanco, Pico del Este, and Pico El Yunque	Unknown	Y
No Common Name (*Mitracarpus maxwelliae*)	FE, TE	Terrestrial	Windswept rocky outcrop with crevices and soil pockets along unpaved road on coastal scrub forest area and cactus scrub forest	Endemic to southwestern Puerto Rico and only known from Monte de la Brea in the Guánica Commonwealth Forest	Stable	Y
No Common Name (*Mitracarpus polycladus*)	FE, TE	Terrestrial	Exposed, rocky limestone outcrops in coastal dwarf forests (short, dense trees), coastal shrub forest, cactus scrub forest, and coastal scrub on sandy soil	Native to Puerto Rico, Anegada Islands and the island of Saba in the Lesser Antilles; in Puerto Rico it is only known at four locations in the Guánica Commonwealth Forest	Increasing	Y
No Common Name (*Lyonia truncata* var. *proctorii*)	FE, TCE	Terrestrial	Steep, rocky, exposed cliffs and ledges	Endemic to Puerto Rico in two subpopulations located on the eastern and northwest cliffs of Cerro Mariquita	Stable	Y
No Common Name (*Eugenia woodburyana*)	FE, TCE	Terrestrial	Subtropical dry forest	Known from the range of hills known as the Sierra Bermeja, three populations within Guanica Commonwealth Forest, Laguna Cartagena National Wildlife Refuge, and Cabo Rojo National Wildlife Refuge	Unknown	Y

Common Name and Scientific Name	Listing Status[a]	Type of Habitat (Terrestrial, Marine, or Freshwater)	General Habitat Description	Geographic Range	Population Status (Stable, Declining, Increasing, Unknown)	Occurrence in Puerto Rico (B=Breeding, Y= Year Round Resident, W=Wintering, M-Migratory)
No Common Name (*Gesneria pauciflora*)	FT	Terrestrial	Serpentine substrates, wet habitats, and predominantly areas on steep rock faces with little or no soil formation (i.e., steep seepages, waterfall spray zones, and above deep pools)	Endemic to Puerto Rico with only three known populations, two in the Maricao Commonwealth Forest, and one on a Lajas River tributary outside of the forest boundaries	Stable	Y
Palma De Manaca (*Calyptronoma rivalis*)	FT, TE	Terrestrial	Riparian species found in mature and young moist limestone evergreen and semi-deciduous forest, and the montane wet evergreen forest	Native to Puerto Rico and other islands of Hispaniola; naturally occurring in Puerto Rico in three localities: Quebrada Collazo, Río Camuy and Río Guajataca; species has been introduced in other forests as part of recovery efforts	Increasing	Y
Palo colorado (*Ternstroemia luquillensis*)	FE, TCE	Terrestrial	Dwarf elfin forest, containing short, small and dense trees or upper montane forest	Endemic to Puerto Rico with only six individual trees historically known to occur in four separate locations of the El Yunque National Forest and Maricao Commonwealth Forest	Unknown	Y
Palo de Jazmin (*Styrax portoricensis*)	FE, TCE	Terrestrial	Upper montane wet forest	Endemic to Puerto Rico; known to occur within El Yunque National Forest	Unknown	Y
Palo de Nigua (*Cornutia obovata*)	FE, TCE	Terrestrial	Dry serpentine or moist limestone-derived soils at elevations of 830 to 3,100 feet within subtropical moist and wet forest	Endemic to Puerto Rico; known to occur in Río Abajo, Aricedo Observatory, Barrenquitas, and possibly in the state forest at Susua	Unknown	Y

Common Name and Scientific Name	Listing Status[a]	Type of Habitat (Terrestrial, Marine, or Freshwater)	General Habitat Description	Geographic Range	Population Status (Stable, Declining, Increasing, Unknown)	Occurrence in Puerto Rico (B=Breeding, Y= Year Round Resident, W=Wintering, M-Migratory)
Palo de Ramon (*Banara vanderbiltii*)	FE, TCE	Terrestrial	Occurs naturally in subtopical moist forests, and appears to occur on both limestone and volcanic substrates	Endemic to Puerto Rico with only 11 known plants in two localities: one at the Río Lajas ward in the municipality of Dorado, and another at Las Piedras del Collado area; species has been introduced in other forests as part of recovery efforts	Unknown	Y
Palo de Rosa (*Ottoschulzia rhodoxylon*)	FE, TCE	Terrestrial	Well drained, rocky serpentine and limestone-derived soils; it appears to have a narrow range of moisture tolerances, and will grow at varied elevations based on local rainfall	Native to western Puerto Rico found in Guaynabo; Quebradillas/Isabela; Cambalache Commonwealth Forest: Guanica Commonwealth Forest; Maricao Commonwealth Forest; Susua Commonwealth Forest; and the Sierra Bermeja in Cabo Rojo; also found in Guánica and Isabela and the Dominican Republic	Unknown	Y
Pelos del Diablo (*Aristida portoricensis*)	FE, TCE	Terrestrial	Serpentine slopes and red clay soils	Endemic to southwestern Puerto Rico and known to occur in Cerro Mariquita in Sierra Bermeja	Stable	Y

Common Name and Scientific Name	Listing Status[a]	Type of Habitat (Terrestrial, Marine, or Freshwater)	General Habitat Description	Geographic Range	Population Status (Stable, Declining, Increasing, Unknown)	Occurrence in Puerto Rico (B=Breeding, Y= Year Round Resident, W=Wintering, M-Migratory)
St. Thomas prickly-ash (*Zanthoxylum thomasianum*)	FE, TE	Terrestrial	Subtropical dry and moist forests, locally found associated with remnants of native vegetation in Puerto Rico, characterized by a high plant diversity and a complex forest structure that include large amounts of leaf litter and the presence of stands of epiphytes (bromeliads and orchids)	Native to Puerto Rico, St. John and St. Thomas in the U.S. Virgin Islands, and Virgin Gorda in the British Virgin Islands; subpopulations known to exist in Puerto Rico are scattered at three sites: northwest area of the island La Cara del Indio in Quebradillas-Isabela), and in the south-central (Piedras Chiquitas between Coamo and Salinas, and the area of Cerro Cariblanco in Camp Santiago, Salinas)	Decreasing	Y
Uvillo (*Eugenia haematocarpa*)	FE, TE	Terrestrial	Submontane rainforest	Endemic to Puerto Rico; known to occur in Sierra de Luquillo (El Yunque National Forest) and from the Sierra de Cayey; range has expanded and now extends to the northwestern corner of Puerto Rico	Increasing	Y
Vahl's boxwood (*Buxus vahlii*)	FE, TE	Terrestrial	Coastal limestone hills, restricted to forested ledges and ravines	Native to southern Puerto Rico, St. Croix, Jamaica, and the U.S. Virgin Islands (where it is now extinct); there are two known locations in the karst region of Northern Puerto Rico at Rincon and Hato Tejas, Bayamon	Stable	Y

Common Name and Scientific Name	**Listing Status[a]**	**Type of Habitat (Terrestrial, Marine, or Freshwater)**	**General Habitat Description**	**Geographic Range**	**Population Status (Stable, Declining, Increasing, Unknown)**	**Occurrence in Puerto Rico (B=Breeding, Y= Year Round Resident, W=Wintering, M-Migratory)**
West Indian walnut (*Juglans jamaicensis*)	FE, TCE	Terrestrial	Wet montane forest	Native to Cuba, Dominican Republic, Haiti, and Puerto Rico; in Puerto Rico, known population is limited to about 20 individuals in Adjuntas, Puerto Rico (including few seedlings); in 2009, more than 50 individuals of the species were planted in the Guilarte Forest as a reintroduction	Unknown	Y
Wheeler's peperomia (*Peperomia wheeleri*)	FE, TE	Terrestrial	Grows in soil deposits located on granodiorite and limestone boulders in semi-evergreen seasonal open forest and subtropical wet forest	Endemic to multiple locations throughout Puerto Rico including Culebra Island, and Isabela in the north of the main island; the species has been propagated and introduced to multiple new locations in a recovery effort	Increasing	Y
No Common Name (*Varronia rupicola*)	FT	Terrestrial	Forested hills with open to relatively dense scrub and shrub lands, low forests, and at the edges of dense, low, coastal shrubland and forest	Puerto Rico within Montalva, Guanica Commonwealth Forest, Montes de Barina, (4) Penon de Ponce, Punta Negra, Puerto Ferro, and Cerro Playuela.; also found in the British Virgin Islands	Unknown	Y
No Common Name (*Leptocerus grantianus*)	FE, TCE	Terrestrial	Dry thickets along rocky coastal shoreline	Endemic only to Culebra Island, with one known population on the southwestern portion of the island	Unknown	Y

Common Name and Scientific Name	Listing Status[a]	Type of Habitat (Terrestrial, Marine, or Freshwater)	General Habitat Description	Geographic Range	Population Status (Stable, Declining, Increasing, Unknown)	Occurrence in Puerto Rico (B=Breeding, Y= Year Round Resident, W=Wintering, M-Migratory)
Birds (8)						
Yellow-shouldered blackbird (*Agelaius xanthomus*)	FE, TE	Terrestrial	Small forest bird that inhabits mostly subtropical dry forests but sometimes occurs in wet forests in the non-breeding season; breeding season coincides with the onset of the rainy season, and can span from February to November, though typically April to August	Endemic to Puerto Rico and known from three distinct areas including the islands of Mona and Monito, the Roosevelt Roads Naval Station, and the forests of southern Puerto Rico	Stable or increasing	Y
Elfin-woods warbler (*Setophaga angelae*)	FT	Terrestrial	Small montane forest warbler that inhabits dense forest foliage; breeding season is thought to occur from March to August	Endemic to Puerto Rico. Known to occur within El Yunque National Forest and the Montane Cloud Forest	Stable	Y
Puerto Rican broad-winged hawk (*Buteo platypterus brunnescens*)	FE, TE	Terrestrial	Large raptor that inhabits several montane forest types as well as hardwood forest plantations, mature secondary forests, and shade coffee plantations; breeding season is typically from January to July	Endemic to Puerto Rico and known from the Río Abajo Commonwealth Forest, Carite Commonwealth Forest, and El Yunque National Forest	Stable	Y
Puerto Rican sharp shinned hawk (*Accipiter striatus venator*)	FT, TE	Terrestrial	Large raptor that inhabits a wide variety of montane forests, rarely found in lower karst forests and coastal plains; breeding season is typically from January to June	Endemic to Puerto Rico and known from the Maricao, Toro Negro, Guilarte, Carite, and El Yunque forests	Stable	Y

Common Name and Scientific Name	Listing Status[a]	Type of Habitat (Terrestrial, Marine, or Freshwater)	General Habitat Description	Geographic Range	Population Status (Stable, Declining, Increasing, Unknown)	Occurrence in Puerto Rico (B=Breeding, Y= Year Round Resident, W=Wintering, M-Migratory)
Roseate tern (*Sterna dougallii dougallii*)	FT	Terrestrial and Marine	Small waterbird that nests almost exclusively on a variety of small cays, or islets with sand-dunes, sand-spits, reefs, saltmarshes, and rocky, grassy, sandy or coral islands during the breeding season (May through Early September); occupies mostly marine habitats during non-breeding season	The Caribbean population breeds from Cuba, the Florida Keys, the Bahamas, Puerto Rico, the Virgin Islands, and south through the Lesser Antilles to Tobago and Trinidad	Unknown (varies widely)	Y
Puerto Rican plain pigeon (*Columba inornata wetmorei*)	FE, TE	Terrestrial	Small bird that is a habitat generalist, and breeds in secondary mature, dense forest near water; mating occurs year round, however typically peaks in late winter and spring; occurs in a variety of edge habitats in the non-breeding season	Throughout inland Puerto Rico	Increasing	Y
Puerto Rican parrot (*Amazona vittata*)	FE, TCE	Terrestrial	Medium-bodied bird that inhabits mature, lowland forest containing palo Colorado trees between 600-1,200 feet above mean sea level; breeding season is between late February and July	Endemic to Puerto Rico and mostly limited to two locations within the Río Abajo and El Yunque commonwealth forests	Increasing from near extinction but population still very small	Y

Common Name and Scientific Name	**Listing Status[a]**	**Type of Habitat (Terrestrial, Marine, or Freshwater)**	**General Habitat Description**	**Geographic Range**	**Population Status (Stable, Declining, Increasing, Unknown)**	**Occurrence in Puerto Rico (B=Breeding, Y= Year Round Resident, W=Wintering, M-Migratory)**
Puerto Rican nightjar (*Caprimulgus noctitherus*)	FE, TE	Terrestrial	Small bird that occupies various forest types but primarily found in coastal dry, lower cordillera forests, and closed canopy dry forest on limestone soils with abundant leaf litter and open understory; breeding occurs from late February through early July	Endemic to Puerto Rico and largely limited to the southern portion of the country	Decreasing	Y
Mammals (6)						
Blue whale (*Balaenoptera musculus*)	FE, TE	Marine	The species feeds on small, planktonic, shrimp-like krill (*Euphausia pacifica* and *Thysanoessa spinifera*) near the ocean's surface	Worldwide distribution, broken into regional groups; infrequently seen in Caribbean waters	Unknown	M
Humpback whale (*Megaptera novaeangliae*)	FE	Marine	Breeds in tropical waters and migrates to temperate and subpolar waters for feeding	Worldwide distribution; migrates to Caribbean waters in winter to breed.	Increasing	M, B
Fin whale (*Balaenoptera physalus*)	FE, TE	Marine	Generally concentrated along frontal boundaries (or mixing zones) between coastal and oceanic waters near 600-foot depth; feeds on fish	Worldwide (offshore and outside of temperate waters); has been noted off southern coast of Puerto Rico	Unknown	M

Common Name and Scientific Name	Listing Status[a]	Type of Habitat (Terrestrial, Marine, or Freshwater)	General Habitat Description	Geographic Range	Population Status (Stable, Declining, Increasing, Unknown)	Occurrence in Puerto Rico (B=Breeding, Y= Year Round Resident, W=Wintering, M-Migratory)
Sei whale (*Balaenoptera borealis*)	FE, TE	Marine	Distribution in open ocean highly variable and related to ocean currents. Strongly associated with ocean fronts and eddies; rare in semi-enclosed seas or gulfs; feeds on copepods (small crustaceans) and euphausiids (shrimp-like crustaceans)	Offshore occurring in the North Atlantic, North Pacific and Southern Hemisphere; an occasional visitor to the Mediterranean Sea	Unknown	M
Sperm whale (*Physeter microcephalus*)	FE	Marine	Occurs offshore in submarine canyons at the edge of the continental shelf or in waters deeper than 600 feet	Worldwide species known throughout Puerto Rican waters	Unknown	Y
West Indian manatee (*Trichechus manatus*)	FE, TE	Marine	Coastal areas, including river deltas	Southern, eastern, and western Puerto Rican coasts; mainly found in Ceiba, Guayama, and Cabo Rojo	Unknown	Y
Reptiles (11)						
Green sea turtle (*Chelonia mydas*)	FT, TE	Marine	Shallow, coastal (i.e., neritic) areas rich in sea grass/marine algae	Circumglobal distribution, inshore and nearshore distribution in Puerto Rico	Decreasing	Y
Loggerhead sea turtle (*Caretta caretta*)	FT	Marine	Coastal neritic areas rich in sea grass/marine algae	Circumglobal distribution throughout temperate and tropical regions of the Atlantic, Pacific, and Indian Oceans	Decreasing	M

Common Name and Scientific Name	Listing Status[a]	Type of Habitat (Terrestrial, Marine, or Freshwater)	General Habitat Description	Geographic Range	Population Status (Stable, Declining, Increasing, Unknown)	Occurrence in Puerto Rico (B=Breeding, Y= Year Round Resident, W=Wintering, M-Migratory)
Hawksbill turtle (*Eretmochelys imbricata*)	FE, TE	Marine	Coastal neritic areas rich in sea grass/marine algae	Circumglobal distribution throughout temperate and tropical regions of the Atlantic, Pacific, and Indian Oceans; primary U.S. distribution is Puerto Rico and the Gulf of Mexico; nesting occurs on Mona Island	Decreasing	Y
Leatherback sea turtle (*Dermochelys coriácea*)	FE, TE	Marine	Coastal neritic areas rich in sea grass/marine algae	Found from tropical to sub-polar oceans, nest on Puerto Rico beaches	Decreasing worldwide, locally increasing	Y
Puerto Rican boa (*Epicrates inornatus*)	FE	Terrestrial	Forests and caves	Endemic to Puerto Rico	Possibly increasing	Y
Virgin Islands tree boa (*Epicrates monensis granti*)	FE, TCE	Terrestrial	Dry, subtropical forests	Endemic to Puerto Rico and the Virgin Islands	Unknown	Y
Mona boa (*Epicrates monensis monensis*)	FT, TE	Terrestrial	Dry, subtropical forests	Endemic to Mona Island	Unknown	Y
Monito's gecko (*Sphaerodactylus micropithecus*)	FE, TCE	Terrestrial	Rocky coastal plateaus, under rocks and logs	Endemic to Monita Island	Unknown	Y
Culebra Island giant anole (*Anolis roosevelti*)	FE, TCE	Terrestrial	Forested slopes	Eastern Puerto Rican islands and the U.S. Virgin Islands	Unknown, possibly extirpated or extinct	Y

Common Name and Scientific Name	Listing Status[a]	Type of Habitat (Terrestrial, Marine, or Freshwater)	General Habitat Description	Geographic Range	Population Status (Stable, Declining, Increasing, Unknown)	Occurrence in Puerto Rico (B=Breeding, Y= Year Round Resident, W=Wintering, M-Migratory)
Cook's anole (*Anolis cook*i)	TE	Terrestrial	Subtropical dry forests and grasslands	Southern and southeastern Puerto Rico and Coffin Island	Unknown	Y
Mona ground iguana (*Cyclura cornuta stejñegeri*)	TE	Terrestrial	Subtropical dry forests and grasslands	Mona Island	Unknown, 2,5000 individuals estimated	Y
Amphibians (6)						
Cave frog/guajon (*Eleutherodactylus cooki*)	FT, TT	Terrestrial	Caves, crevices, and fissures at elevations from 300-1,000 feet	Endemic to southeastern Puerto Rico	Unknown	Y
Golden coqui (*Eleutherodactylus jasper*)	FT, TCE	Terrestrial	Forests	Endemic to the Bromelias forest in Puerto Rico	Unknown, believed extinct	Y
Llanero coqui (*Eleutherodactylus juanariveroi*)	FE	Terrestrial	Forests	Endemic only to northern Puerto Rico	Unknown	Y
Mottled coqui (*Eleutherodactylus eneidae*)	TCE	Terrestrial	Cloud forests (forests that receive precipitation directly from the clouds that cover the forest)	Endemic to Puerto Rico and occurs in El Yunque and Toro Negro commonwealth forests	Unknown, possibly extinct	Y
Webbed footed coqui (*Eleutherodactylus karlschmidti*)	TCE	Terrestrial	Mountains, rocks, and boulders located at elevations from 150-1,200 feet above sea level in association with river, stream, and waterfall spray	Endemic to Puerto Rico and occurs in El Yunque Commonwealth Forest and interior western Puerto Rico	Unknown, possibly extinct	Y
Puerto Rican crested toad (*Peltophryne lemur*)	FT, TE (southern population)/TCE (northern population)	Terrestrial	Fissures and cracks in rocks	Endemic to Puerto Rico; two genetically distinct populations are known, one in north coast limestone rocks and cliffs and the other in the Guanica Commonwealth Forest	Unknown	Y

Common Name and Scientific Name	**Listing Status**[a]	**Type of Habitat (Terrestrial, Marine, or Freshwater)**	**General Habitat Description**	**Geographic Range**	**Population Status (Stable, Declining, Increasing, Unknown)**	**Occurrence in Puerto Rico (B=Breeding, Y= Year Round Resident, W=Wintering, M-Migratory)**
Fish (4)						
Scalloped hammerhead shark (*Sphyrna lewini*)	FT	Marine	Offshore shelves near deep water, can also be found inshore, including in estuaries	Globally distributed throughout temperate and tropical waters	Local distinct population decreasing	M
Nassau grouper (*Epinephelus striatus*)	FT,TE	Marine	From shallow waters to up to 300 feet deep; primarily found near coral reefs	Southern Gulf of Mexico and Caribbean from the Yucatan to the Bahamas	Unknown	Y
Goliath grouper (*Epinephelus itajitara*)	TCE	Marine	Shallow tropical coral reef waters	Tropical and subtropical Atlantic Ocean from North Carolina to Brazil, east to Senegal and Congo, the Gulf of Mexico, and the Caribbean	Increasing	Y
Hognose mullet (*Joturus pichardi*)	TCE	Freshwater and brackish waters	Freshwater rivers	Central America from Mexico to Panama, Florida, West Indies. In Puerto Rico occurs in the Río Anasco	Unknown	Y
Invertebrates (10)						
Mona's cave shrimp (*Typhlatya monae*)	TCE	Subterranean Freshwater	Ponds inside caves	Restricted to two localities: Mona Island and Guánica Forest	Unknown	Y
Blind amphipod/fresh water cave shrimp (*Alloweckellia gurnee*)	TCE	Subterranean Freshwater	Ponds inside caves	Unknown but limited to subterranean aquatic habitats, so likely very limited	Unknown	Y
Puerto Rico harlequin butterfly (*Atlantea tulita*)	TCE	Terrestrial	Open fields and grasslands containing *Oplonia spinosa*	Northern karst areas of Puerto Rico	Unknown	Y
Elkhorn corals (*Acropora palmata*)	FT	Marine	Outer reef slopes, especially in areas exposed to wave action; typically a shallow water species	Shallow tropical waters throughout the Gulf of Mexico and Caribbean	Stable	Y

Common Name and Scientific Name	Listing Status[a]	Type of Habitat (Terrestrial, Marine, or Freshwater)	General Habitat Description	Geographic Range	Population Status (Stable, Declining, Increasing, Unknown)	Occurrence in Puerto Rico (B=Breeding, Y= Year Round Resident, W=Wintering, M-Migratory)
Staghorn corals (*Acropora cervicornis*)	FT	Marine	Upper to middle zone of sloping coral reef; also found in lagoons	Throughout the Caribbean Sea, southern Gulf of Mexico, Florida, and the Bahamas	Stable	Y
Pillar coral (*Dendrogyra cylindrus*)	FT	Marine	Back reef and shore reef slopes, usually within 50 feet of the surface; most common in sheltered areas; uncommon in exposed portions of the reef	Throughout the Caribbean Sea, southern Gulf of Mexico, Florida, and the Bahamas	Unknown	Y
Rough cactus coral (*Mycetophyllia ferox*)	FT	Marine	Most common in fore-reef environments from 30-60 feet in depth, although occurs shallower occasionally and can sometimes be found in deeper back reefs and lagoons	Shallow tropical waters throughout the Gulf of Mexico and Caribbean	Unknown	Y
Lobed star coral (*Orbicella annularis*)	FT	Marine	Coral reefs	Shallow tropical waters throughout the Gulf of Mexico and Caribbean	Unknown	Y
Mountainous star coral (*Orbicella faveolata*)	FT	Marine	Coral reefs	Shallow tropical waters throughout the Gulf of Mexico and Caribbean	Unknown	Y

Common Name and Scientific Name	Listing Status[a]	Type of Habitat (Terrestrial, Marine, or Freshwater)	General Habitat Description	Geographic Range	Population Status (Stable, Declining, Increasing, Unknown)	Occurrence in Puerto Rico (B=Breeding, Y= Year Round Resident, W=Wintering, M-Migratory)
Boulder star coral (*Orbicella franksi*)	FT	Marine	Coral reefs	Shallow tropical waters throughout the Gulf of Mexico and Caribbean	Unknown	Y

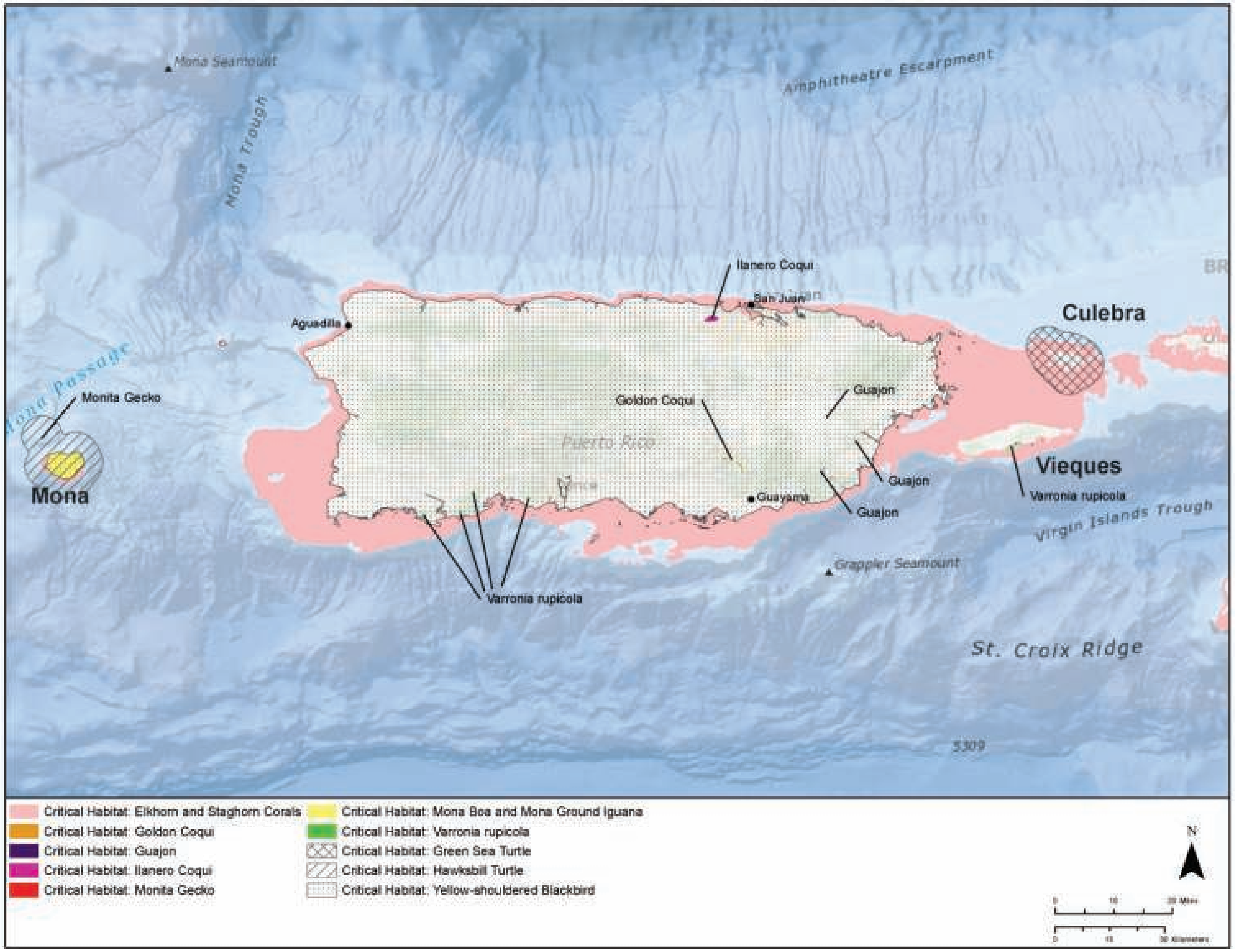
Sources: Cahill 2015; PRDNER2005; IUCN 2015; MESA 2015; NMFS 2015; USFWS 2016a; USFWS 2015b; NOAA 2016; Walter 2015; Weil 2015

[a] Listing Status: FE = Federally Endangered; FT = Federally Threatened; TCE= Territory Critically Endangered; TE = Territory Endangered; TT = Territory Threatened. Species listed as Territory Data Deficient are not included in this table due to lack of information on these species' population status.

Critical Habitat

Several species in Puerto Rico have critical habitat that has been designated by the USFWS or National Marine Fisheries Service (see Figure 8.1.6.6-1). These species and a brief description of the location of their critical habitat in Puerto Rico are listed below by taxa.

- Plants
  - *Varronia rupicola* – Seven designated critical habitat units, including four on mainland Puerto Rico and three on the island of Vieques: 1) Montalva, 2) Guánica Commonwealth Forest, 3) Montes de Barinas, 4) Peñon de Ponce, 5) Punta Negra, 6) Puerto Ferro, and 7) Cerro Playuela
- Birds
  - Yellow-shouldered blackbird (*Agelaius xanthomus*) – All of Mona Island and portions of the main island of Puerto Rico
  - Elfin-Woods Warbler (*Setophaga angelae*) – This species has critical habitat that is proposed by the USFWS in June 2016 (*USFWS 2016b)*. These areas include 10,977 hectares in the Maricao, San Germán, Sabana Grande, Yauco, Río Grande, Canovanas, Las Piedras, Naguabo, Ceiba, Cayey, San Lorenzo, Guayama, and Patillas Municipalities
- Reptiles
  - Green sea turtle (*Chelonius mydas*) – Culebra Island coastal waters, including outlying keys
  - Hawksbill Turtle (*Eretmochelys imbricata*) – Mona and Monito Island coastal waters, northern Culebra Island, southern Cayo Norte, and southwest, east, and north beaches of Culebrita Island
  - Mona boa (*Epicrates monensis monensis*) – All of Mona Island
  - Mona ground iguana (*Cyclura cornuta stejñegeri*) – All of Mona Island
  - Monita gecko (*Sphaterodactylus mocropitecus*) – All of Isla Monito
- Amphibians
  - Guajon (*Eleutherodactylus cooki*) – Portions of Humacao, Juncos, Las Piedras, Maunabo, Patillas, San Lorenzo, and Yabucoa
  - Golden coqui (*Eleutherodactylus jasper*) – Cerro Avispa, Monte el Gato, and Sierra de Cayey at elevations above 2,100 feet mean sea level
  - Ilanero coqui (*Eleutherodactylus juanariveroi*) – Portions of Toa Baja
- Invertebrates
  - Elkhorn and staghorn corals (*Acropora* spp.) – Coastal reefs surrounding Puerto Rico



Sources: NMFS 2008, NMFS 1998a, NMFS 1998b, USFWS 1976, USFWS 1977, USFWS 1978a, USFWS 1978b, USFWS 1982, USFWS 2007, USFWS 2012, USFWS 2014

Note: Critical habitat areas for the elfin-woods warbler are not included in the map but are described above.

Figure 8.1.6.6-1: Critical Habitat Designations in Puerto Rico

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8.1.7. Land Use, Airspace, and Recreation

8.1.7.1. Introduction

This section provides a broad overview of land use, airspace, and recreational facilities and activities in Puerto Rico. This includes regulations, conditions, and activities that could potentially be affected by deployment and operation of the Proposed Action. The following summarizes major land uses, recreational venues, and airspace considerations, and characterizes existing, baseline conditions for use in evaluating the potential environmental consequences resulting from implementing the Proposed Action.

Land Use and Recreation

Land use is defined as "the arrangements, activities and inputs people undertake in a certain land cover type to produce, change, or maintain it" (*Di Gregorio and Jansen 1998*). A land use designation can include one or more pieces of land, and multiple land uses may occur on the same piece of land. Land use also includes the physical cover, observed on the ground or remote sensing and mapping, on the earth's surface; land cover includes vegetation and manmade development (*USGS 2012b*).

Recreational uses are activities in which residents and visitors participate. They include outdoor activities, such as hiking, fishing, boating, athletic events (e.g., golf and boating), and other attractions (e.g., historic monuments and cultural sites) or indoor activities, such as museums and historic sites. Recreational resources can include trails, beaches, caves, lakes, forests, beaches, recreational facilities, museums, historic sites, and other outdoor areas. Recreational resources are managed by all levels of government including federal, territory, county, or local governments.

Land uses are typically defined and managed by local governments, and the categories of land use can vary considerably from jurisdiction to jurisdiction. As a result, this Final Programmatic Environmental Impact Statement refers to land use/land cover, as defined in the National Land Cover Database (*USGS 2001*), a standardized set of 21 categories defined by the U.S. Geological Survey that incorporates both land use and land cover characteristics. Where appropriate, or important to convey local conditions, more general land use categories such as forest, agricultural, and developed are also used. Descriptions of land ownership are presented in four main categories: private, federal, state, and tribal, although other geographically specific terms (such as municipal) are used where appropriate. Descriptions of recreational opportunities are presented in a regional fashion, highlighting areas of recreational significance within 12 identified regions.

Airspace

Airspace is generally defined as the space lying above the earth, above a certain area of land or water, or above a nation and the territories that it controls, including territorial waters (*Merriam Webster Dictionary 2015*). Airspace is a finite resource that can be defined vertically and horizontally, as well as temporally, when discussing it in relation to aircraft activities. Airspace management addresses how and in what airspace aircraft fly. Air flight safety considers aircraft flight risks, such as aircraft mishaps and bird/animal-aircraft strikes. The Federal Aviation Administration (FAA) is charged with the safe and efficient use of the nation's airspace and has established criteria and limits to its use.

The FAA operates a network of airport towers, air route traffic control centers, and flight service stations. The FAA also develops air traffic rules, assigns use of airspace, and controls air traffic in U.S. airspace. "The Air Traffic Organization (ATO) is the operational arm of the FAA responsible for providing safe and efficient air navigation services to approximately 30.2 million square miles of airspace. This represents more than 17 percent of the world's airspace and includes all of the U.S. and large portions of the Atlantic and Pacific Oceans and the Gulf of Mexico" (*FAA 2014*). The ATO is comprised of Service Units (organizations) that support the operational requirements.

The FAA Air Traffic Services Unit (the Unit) manages the National Airspace System and international airspace assigned to U.S. control and is responsible for ensuring efficient use, security, and safety of the nation's airspace. FAA field and regional offices (e.g., Aircraft Certification Offices, Airports Regional Offices, Flight Standards District Offices, Regional Offices & Aeronautical Center, etc.) assist in regulating civil aviation to promote safety, and develop and carry out programs that control aircraft noise and other environmental effects (e.g., air pollutants) attributed from civil aviation (*FAA 2015c*). The FAA works with state aviation officials and airport planners, military airspace managers, and other organizations in deciding how best to use airspace. As explained below, the FAA must be contacted for proposed construction or alteration of structures (such as cell towers) within navigable airspace that meet specific criteria.

8.1.7.2. Specific Regulatory Considerations

Land Use

Land use in Puerto Rico is guided by *Section 19 of Article VI of Puerto Rico's Constitution*, which states "The public policy of the Commonwealth shall be to: more effectively conserve natural resources, as well as further the development and use of them for the general benefit of the community; conservation and maintenance of buildings and places that are declared of historic or artistic value by the Legislature ..." The planning system in Puerto Rico was amended by the Autonomous Municipalities Act of 1991 *(Act. 81 Chapter XIII*), which requires each of the 78 municipalities of Puerto Rico to have a land use plan and revise it every 8 years (*Commonwealth of Puerto Rico Planning Board 2014; Universidad Metropolitana 2007*).

The Puerto Rico Land Use Plan Act of 2004 (*Laws of Puerto Rico Title 23, Chapter 16*) was enacted to develop an island-wide land use plan and requires the development of a set of indicators to evaluate land use policies (*Universidad Metropolitana 2007*). A draft Land Use Plan was released for public review on December 19, 2014. The "strategies for implementation" portion of the territory plan states that to

> "...[A]chieve the guiding principles, goals and objectives of the Land Use Plan, we must align and coordinate programs of state capitals and municipalities improvements, programs (whether or not capital improvements), and policies and procedures for development, revitalization, conservation and sustainability. The various state agencies and public corporations will work with the Planning Board to develop implementation strategies compatible with legal and public responsibilities. Implementation strategies are also intended to promote coordination and collaboration with municipal governments to achieve the goals and objectives of the Plan. Implementation strategies should use functional areas, as appropriate, to strengthen the focus of development, revitalization and conservation..." (*Commonwealth of Puerto Rico Planning Board 2014*)

Municipalities with plans must initiate a review process of their plans to harmonize and establish the corresponding qualifications in accordance with the provisions of the [territory] Land Use Plan (*Commonwealth of Puerto Rico Planning Board 2014).*

The Planning Board is responsible for classifying land (and evaluating requests for amendment to existing classifications) in Puerto Rico. The Land Use Plan establishes three basic classifications (urban, urbanizable land, and rural) arising from the Autonomous Municipalities Act, to which eight additional sub-classifications based on soil classifications have been added (*Commonwealth of Puerto Rico Planning Board 2014,* descriptions quoted from the *Autonomous Municipalities Act of the Commonwealth of Puerto Rico of 1991 [Act 81-1991]*):

- **Urban Land**: "...[T]he lands that have road access, water and electrical energy supplies and any other infrastructure needed to carry out the administrative, economic and social activities conducted in this land and that are included within areas consolidated by buildings."
- **Urbanizable Land**: "...[T]he land that the territorial plan declares as suitable to be urbanized on the basis of the need of land to accommodate the growth of the municipality in an eight year period and comply with the goals and objectives of the territorial ordinance. This land classification includes the categories of programmed and non-programmed urbanizable lands."
- **Rural Land**: "...[T]he land that the territorial plan considers must be expressly protected from the urbanizing process due to, among other reasons, its present or potential agricultural and cattle raising value; its natural value and its present or potential recreational value, as well as from risks to the public safety or health, or because they are not necessary to fulfill the expectations for urban growth in a foreseeable future of eight (8) years. This land classification shall include the categories comprising common rural lands as well as specially

protected rural lands [which includes subcategories of ecology, agriculture, water, and landscape based on soil classifications]."

Within these broad territory policies, municipality governments determine specific land use categories, goals, policies, and implementation procedures through municipality general plans and zoning. Under the Puerto Rico Land Use Plan Act, municipality plans and zoning must be generally consistent with the territory plan and land classification system. Thus, for example, a municipality plan may not encourage a residential area on land designated as specially protected rural lands by the territory plan (*Laws of Puerto Rico Title 23, Chapter 16*).

Whereas general plans indicate the overall intent of the municipality's land use policy, zoning codifies that intent with specific requirements such as a list of permitted land uses, maximum residential density (e.g., number of dwelling units per acre), and maximum building height (*Laws of Puerto Rico Title 23, Chapter 16*).

In general, the zoning codes for Puerto Rico's municipalities regulate the location, height, and other characteristics of telecommunications equipment (especially, but not necessarily exclusively, aboveground facilities such as cell towers). On federal lands, such regulations may be contained in each facility's relevant establishing legislation or other adopted management policies.

Airspace

The FAA has jurisdiction over air traffic in the United States (U.S.), and must be contacted for proposed construction or alteration of objects within navigable airspace that meet the following criteria (*14 CFR § 77, commonly known as Part 77 regulations*):

- Any construction or alteration that is more than 200 feet above ground level at the structure's proposed location; (including buildings, wind turbines, communications towers, etc.); or
- Construction or alteration that exceeds certain imaginary surfaces extending outward and upward from an airport, seaplane base, or heliport. Imaginary surfaces are three-dimensional shapes surrounding aviation facilities within which development is limited or prohibited in order to ensure safe aviation and minimize the potential effects of crashes.

FAA review of proposed construction or alteration within the spaces listed above could result in denial of permission for construction/alteration, or approval of construction/alteration with or without additional marking /or lighting (*FAA 2016*). Section 8.1.8, Visual Resources, discusses FAA lighting regulations. Certain airspace in the U.S. reserved or intended for military use is managed jointly by the FAA and the Department of Defense (DOD). Military airspace in Puerto Rico includes Military Operations Areas, Military Training Routes (MTRs), and various types of restricted or prohibited airspace.

Recreation

Puerto Rico contains a variety of federal, territory, and local (municipality) recreational lands, ranging from units of the National Park System and National Wildlife Refuges to city and municipality parks. Each of these facilities is administered according to the applicable federal, territory, or local law, along with management documents prepared for that facility. For example, the National Park Service prepares a Superintendent's Compendium document for each of its units, enumerating park-specific restrictions, closures, permit requirements, and other regulations. The National Resources Conservation Service holds easements on land nationwide that restrict construction and other management activities.

8.1.7.3. Land Use and Ownership

Land Use/Land Cover

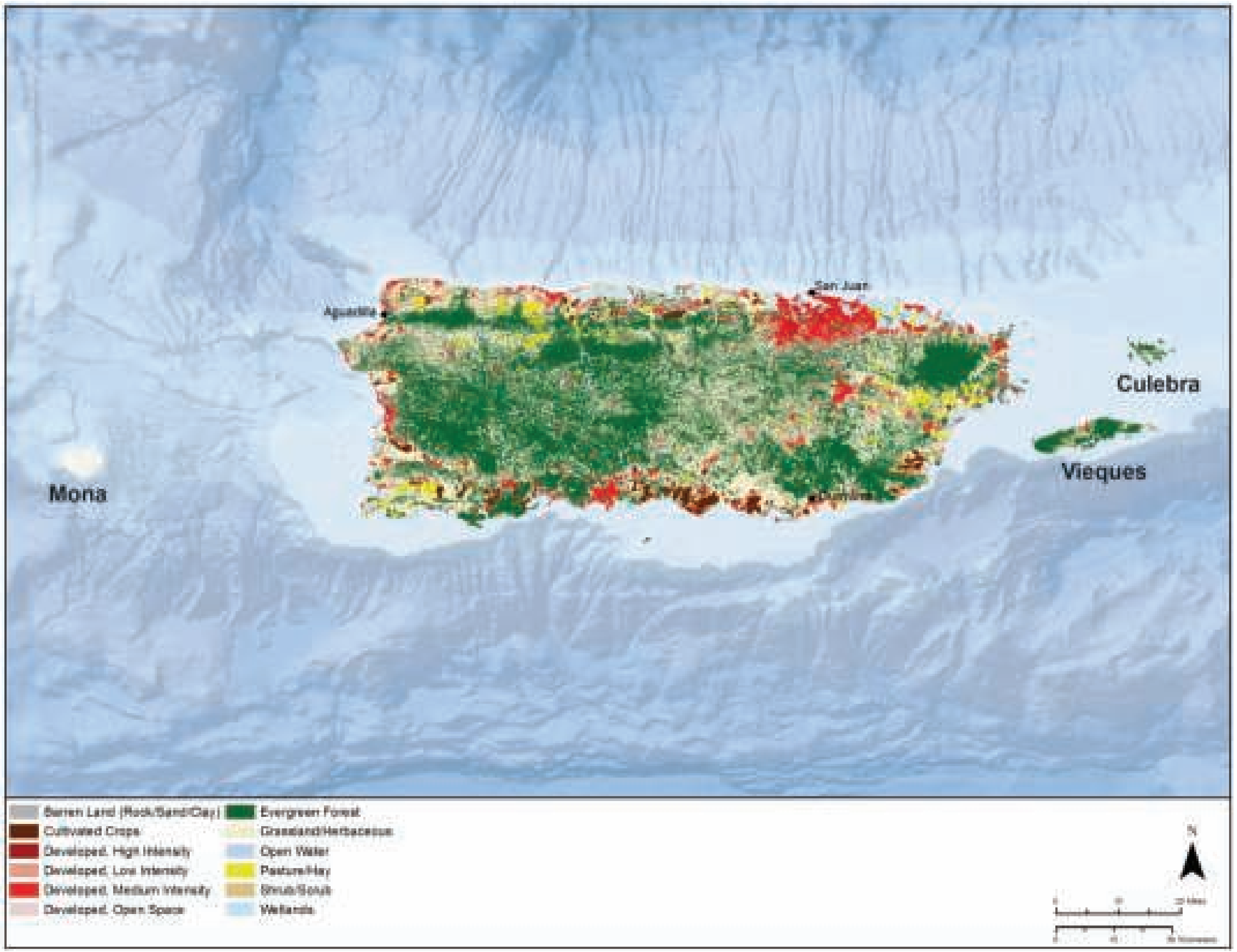
Land use/land cover refers to the use of land, as visible from the air (or satellites). Figure 8.1.7-1 and Table 8.1.7-1 show the distribution of land use/land cover in Puerto Rico. As shown in Table 8.1.7-1, evergreen forest and grassland/herbaceous account for 74 percent of land cover in Puerto Rico. Developed land covers less than 15 percent of the territory, and is generally concentrated in more coastal areas. Scrub/shrub—which includes shrubs and smaller trees (*MRLC 2014*)—pasture/hay, and wetlands each account for approximately 3 percent of land cover of Puerto Rico.

Table 8.1.7-1: Land Use/Land Cover in Puerto Rico

Land Use/Land Cover	Acres[a]	Percent of Total[b]
Open water	13,560	<1%
Developed, Open Space	59,975	3%
Developed, Low Intensity	150,903	7%
Developed, Medium Intensity	94,595	4%
Developed, High Intensity	14,293	<1%
Barren Land	13,288	<1%
Evergreen Forest	1,004,563	46%
Scrub/Shrub	56,986	3%
Grassland/Herbaceous	623,267	28%
Pasture/Hay	58,432	3%
Cultivated Crops	48,891	2%
Wetlands	60,807	3%
Total[c]	**2,199,557**	**100%**

Source: USGS 2001

[a] Totals may not match due to rounding.
[b] Percent of the island's total land area within each land use/land cover
[c] The *USGS 2001* dataset used in this table includes substantial offshore and inland areas categorized as open water. Because offshore areas could not easily be segregated, the total acreages of land cover here may be higher than the land area of Puerto Rico, as reported in other portions of this Final Programmatic Environmental Impact Statement.



Source: USGS 2001

Figure 8.1.7-1: Land Use/Land Cover in Puerto Rico

Land Ownership

Table 8.1.7-2 lists major land owners in Puerto Rico. Ownership information is not readily available for approximately 89 percent of Puerto Rico. This land is assumed to be privately owned, although this assumption has not been verified.

Table 8.1.7-2: Major Land Owners in Puerto Rico

Major Land Owners	Acres[a]	Percent of Total[b]
Federal	83,702	4%
Territorial (Puerto Rico Government)	39,355	2%
State (local government)	99,983	5%
Non-Governmental Organization	18,007	1%
Jointly Owned	1,954	<1%
Other (assumed to be privately owned)	1,967,033	89%
Total[c]	**2,210,033**	**100%**

Source: USGS 2012a

[a] Totals may not match due to rounding.
[b] Percentage of territory held by each ownership type
[c] See footnote c in Table 8.1.7-1.

Based on land whose ownership is specified in the *USGS 2012a* dataset (summarized in Table 8.1.7-2), the federal government owns approximately four percent of land in the territory; the territorial government owns 2 percent, and local (state) government owns 5 percent.

Major federal lands in Puerto Rico include the San Juan National Historic Site (a unit of the National Park Service), U.S. Forest Service, National Wildlife Refuges, and DOD lands. The El Yunque National Forest is the largest block of federal land in Puerto Rico at 28,000 acres in size, and is the only official tropical rainforest in the U.S. Forest Service system. The eastern half of Vieques Island, as well as a portion of the western half of the island, comprises the Vieques National Wildlife Refuge, which is 17,771 acres in size. The entire island of Desecheo, which is located off the northwest coast of Puerto Rico, is a national wildlife refuge of the U.S. Fish and Wildlife Service. Major DOD landholdings include the 746-acre Fort Buchanan, which supports local veterans and reserve units, and the Muñiz Air National Guard Base, which is located within the grounds of the Luis Muñoz Marin International Airport.

Most territorially owned land is managed by the Puerto Rico Department of Natural and Environment, in the form of Puerto Rico Nature Reserve lands.

Jointly owned lands comprise less than one percent of the land in the territory, while non-governmental organization ownership accounts for approximately one percent of land.

8.1.7.4. Airspace

There are 16 civilian airports in Puerto Rico, including 14 on the island of Puerto Rico, and one each on Culebra and Vieques (*PRPA 2015; FAA 2015a*). Ten of these airports are served by commercial airlines, including overseas (international or mainland U.S.) flights and interisland commercial airlines. Luis Muñoz Marin International Airport is the largest and busiest airport in the territory, serving more than 4 million passengers per year (*FAA 2015b*).

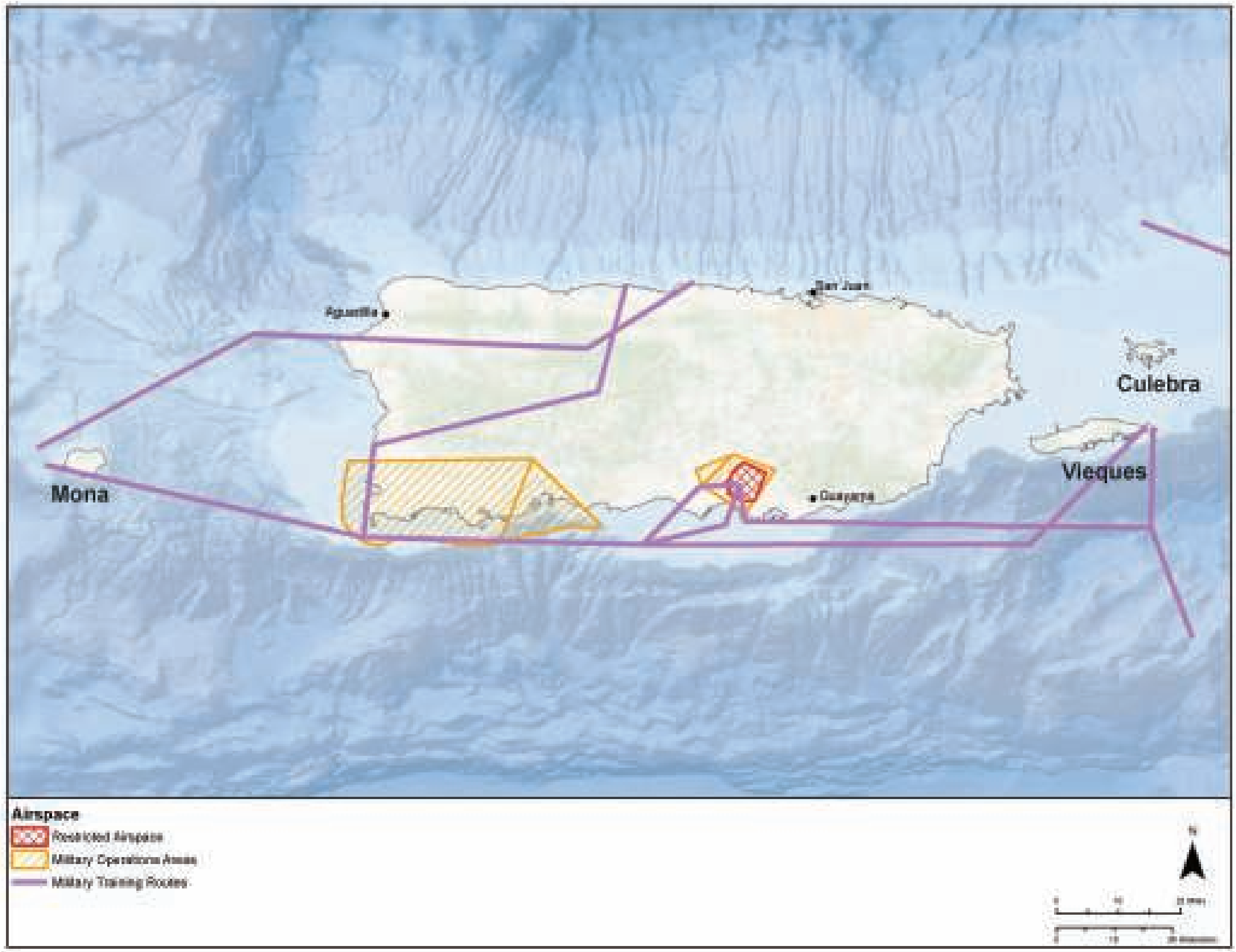
In addition to civilian airports, there are 31 heliports and 2 seaplane bases in Puerto Rico. One of the heliports, Fort Buchanan, is restricted to military use (*FAA 2015a*). The Muñiz Puerto Rico Air National Guard Base uses runways and airfields at Luis Muñoz Marin International Airport.

As described in Section 8.1.7.2, Specific Regulatory Considerations, airspace immediately surrounding airports is subject to Part 77 regulations, which generally govern the placement, height, and use of structures near airports and their runway approaches. There are three adjoining areas of restricted airspace not associated with the Part 77 airspace around airports in Puerto Rico, and four Military Operations Areas, as shown in Figure 8.1.7-2.

Restricted airspace overlays Camp Santiago, a Puerto Rico National Guard base near Salinas on Puerto Rico's south-central coast. Two adjoining Military Operations Areas also overlay Camp Salinas and surrounding areas, while two additional adjoining Military Operations Areas over Puerto Rico's southwestern corner. Military Operations Areas identify airspace designated for military training activities, but where civilian aviation is permitted—often with some restrictions or requirements for advanced notification (*FAA 2008*). Military Operations Areas in Puerto Rico cover approximately 208,000 acres of land.

In addition, as shown on Figure 8.1.7-2, MTRs link these special airspace areas, as well as the islands of Mona and Vieques. MTRs generally traverse the southern and northwestern portions of the island of Puerto Rico. MTRs are "are routes used by military aircraft to maintain proficiency in tactical flying," including some designated low-level (below 1,500 feet above sea level) activities (*FAA 2008*).

Other existing airspace obstructions include existing communications antennas and unmarked balloons on a cable emanating from near the Laguna Cartegena National Refuge.



Source: FAA 2015d

Figure 8.1.7-2: Puerto Rico Airspace

8.1.7.5. Recreation

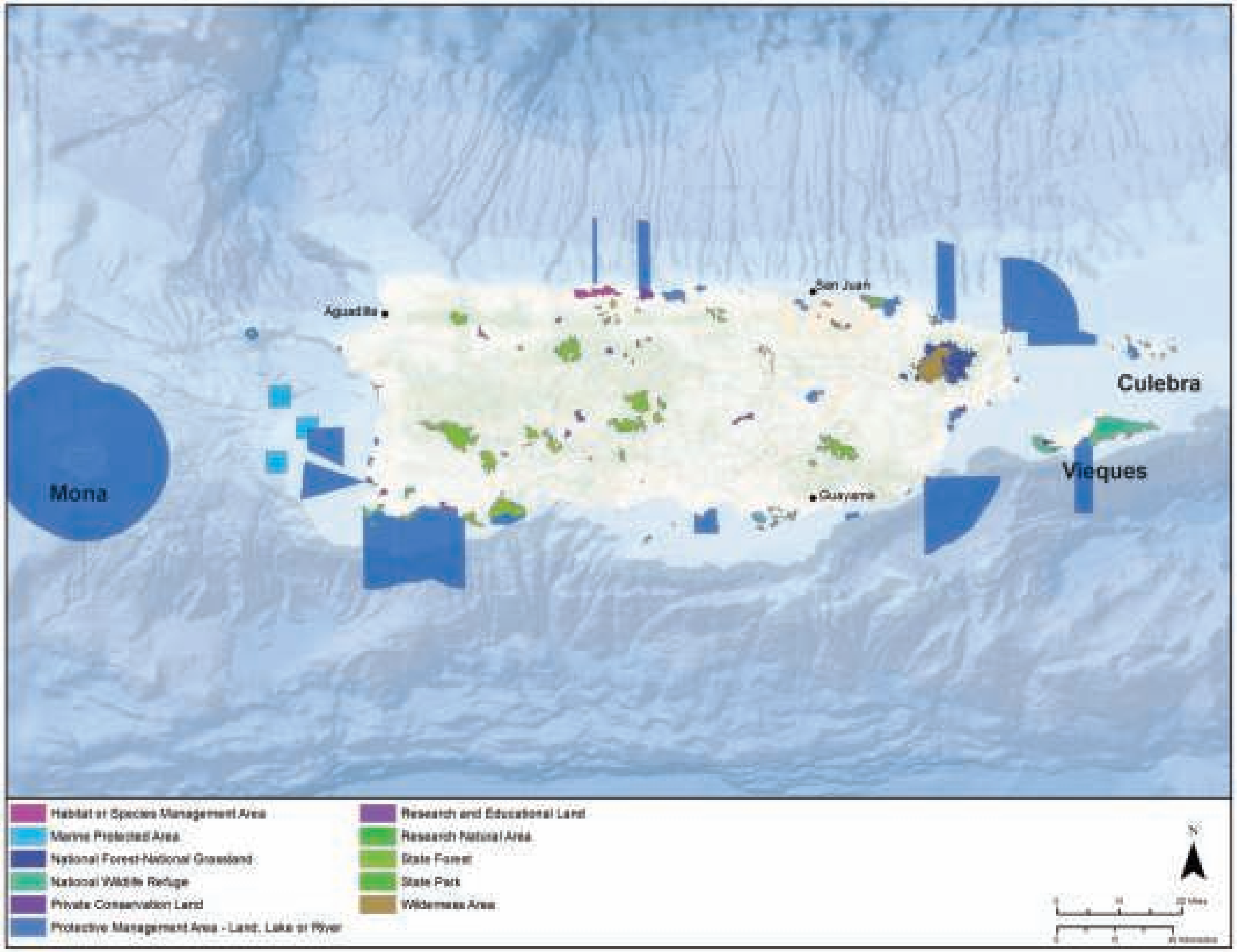
Figure 8.1.7-3 shows federal, territory, and locally owned or managed land in Puerto Rico that is intended or generally available for public recreation. Such land generally includes public parks and recreation facilities (including large athletic fields at public schools), forests, wildlife refuges, and other lands the public might reasonably expect to be able to use for recreation.

Table 8.1.7-3 summarizes the acreage of recreation land by type. As shown in this table, territorial recreation lands account for more than 76 percent of recreational lands in Puerto Rico, with approximately 38 percent of the territory's recreational lands in natural areas and 32 percent in state forests.[1] Federal lands, including El Yunque National Forest, National Wildlife Refuges, and San Juan National Historic Site, comprise approximately 24 percent of recreation land in Puerto Rico. El Yunque National Forest encompasses approximately 28,000 acres and is the only official tropical rainforest in the U.S. Forest Service System.

Puerto Rico offers a wide variety of offshore recreation opportunities, such as snorkeling, diving, fishing, and recreational boating. Section 8.1.6, Biological Resources, summarizes offshore ecological communities, including fisheries. Notable restrictions on ocean use include the following:

- The Isla de Desecheo Marine Reserve: The marine reserve comprises 0.5 nautical miles around Desecheo Island. The island itself is a national wildlife refuge managed by the U.S. Fish and Wildlife Service, while the marine reserve is managed by the Puerto Rico Department of Natural and Environmental Resources, and is a no-take area, meaning that any type of fishing or other extractive activities are prohibited throughout the reserve.
- The Tres Palmas Marine Reserve: Located in the municipality of Rincón, at the northwest corner of the main island of Puerto Rico, the reserve is managed by the Department of Natural and Environmental Resources; however, it is not a designated no-take area.
- Marine Protected Areas: There are four Marine Protected Areas that the Puerto Rico government jointly manages with the federal government. These Marine Protected Areas are the Jobos Bay National Estuarine Research Reserve, jointly managed with the National Oceanic and Atmospheric Administration, and three seasonal closure areas for spawning aggregations of red hind grouper (*Epinephelus guttatus*): Tourmaline Bank, Bajo de Cico, and Abrir La Sierra. The closure areas are located off the west coast of Puerto Rico and were established in conjunction with the Caribbean Fisheries Management Council.

[1] Although Puerto Rico is not a U.S. state, the Spanish-language name of many territorially controlled recreational lands translates literally to state forest or state natural area, etc. This convention is continued in this section.



Source: USGS 2012a

Figure 8.1.7-3: Recreational Areas

Table 8.1.7-3: Acreage of Recreational Lands in Puerto Rico, by Type

Recreational Land Type	Total	
	Acres[a]	Percent of Total[b]
National Wildlife Refuge	19,156	10%
National Forest	28,304	14%
National Park Service	75	<1%
Territorial Natural Reserve	76,228	38%
State (Territorial) Forest	63,276	32%
State (Territorial) Wildlife Refuge	6,733	3%
Territorial Protected Natural Area	3,551	2%
National Estuarine Research Reserve[c]	2,070	1%
Territorial Research and Educational Land	423	<1%
State (Territorial) Park	565	<1%
Private Conservation	146	<1%
Total	200,528	100%

Source: USGS 2012a; NPCA 2015

[a] Totals may not match due to rounding.
[b] Percent of the island's total recreational land area within each recreational land type
[c] Consists of the Jobos Bay National Estuarine Research Reserve, which is managed jointly by the Puerto Rico Department of Natural and Environmental Resources (lead agency), and the National Oceanic and Atmospheric Administration. Because the territorial government is the lead agency, this property is considered territorial recreation lands.

8.1.8. Visual Resources

8.1.8.1. Introduction

Visual resources refer collectively to the natural and manmade features, landforms, structures, and other objects visible from a single location or a broader landscape. Visual resources influence the human experience of a landscape. Various aspects combine to create visual resources, such as color, contrast, texture, line, and form. Features (e.g., mountain ranges, city skylines, ocean views, unique geological formations, rivers) and constructed landmarks (e.g., bridges, memorials, cultural resources, or statues) are considered visual resources. For some, cityscapes are valued visual resources, whereas others prefer natural areas. While many aspects of visual resources are subjective, evaluating potential impacts on the character and continuity of the landscape is a consideration when evaluating proposed actions for National Environmental Policy Act (NEPA) and National Historic Preservation Act compliance. A general definition of visual resources used by the Bureau of Land Management is "the visible physical features on a landscape (e.g., land, water, vegetation, animals, structures, and other features)" (*BLM 1984*). This section provides a broad overview of visual resources in Puerto Rico. This includes regulations, conditions, and activities that could potentially be affected by deployment and operation of the Proposed Action.

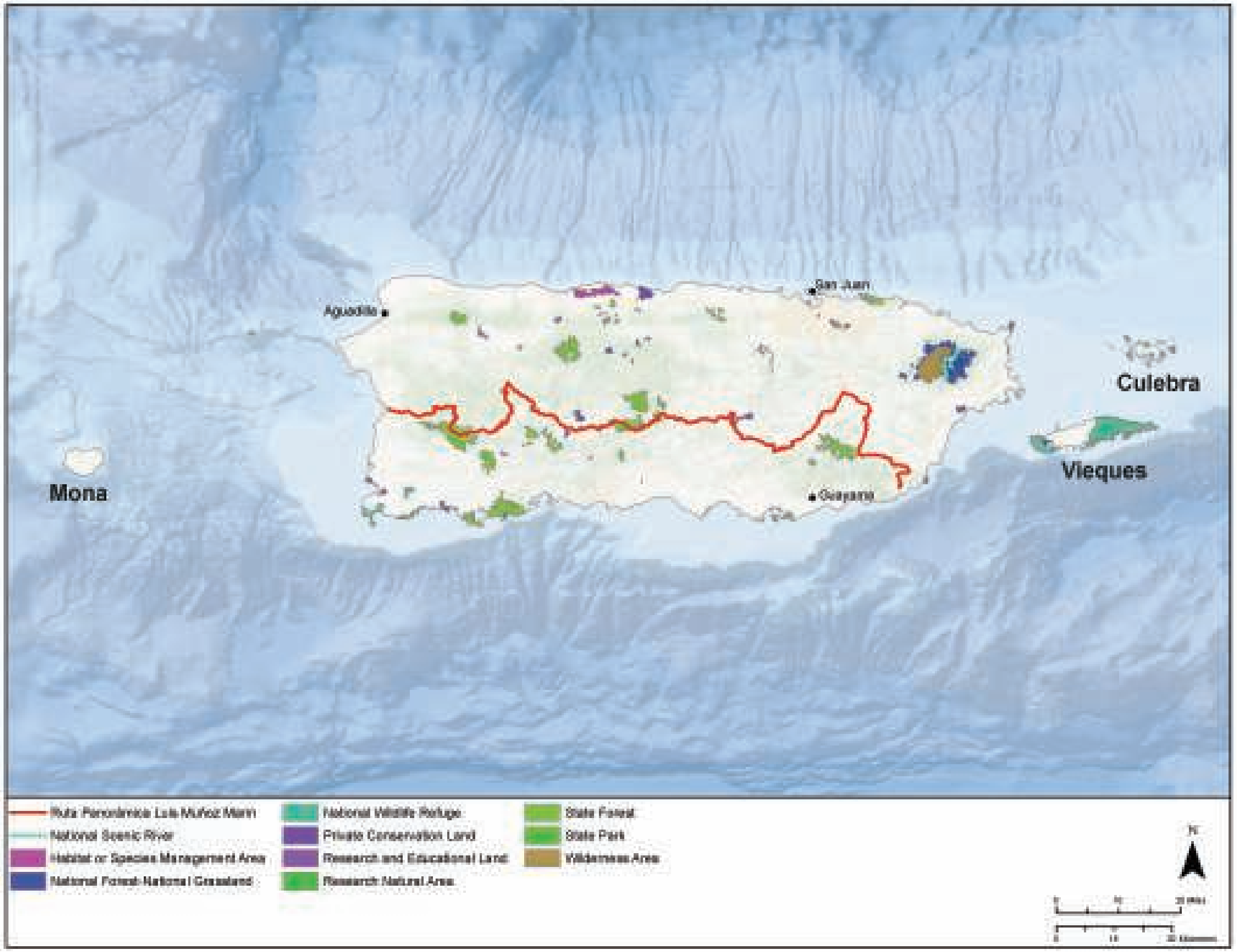
8.1.8.2. Specific Regulatory Considerations

Federal Lands

As described in Section 8.1.7, Land Use, Airspace, and Recreation, the major federal landholders in Puerto Rico are the Department of Defense (DOD), Forest Service, National Park Service (NPS), and U.S. Fish and Wildlife Service (USFWS). DOD facilities are not evaluated here, because DOD facilities are not evaluated here because any deployment on DOD lands will have to comply with DOD requirements associated with visual concerns.

Figure 8.1.8-1 shows federal and territory areas (other than DOD lands) that are managed to address visual resources, while Section 8.1.7, Land Use, Airspace, and Recreation, describes those lands. These recreational areas are also generally managed to address visual resources, except for offshore marine protected areas and management areas. While agency-specific guidelines for complying with NEPA typically require consideration of visual impacts, there is no overall federal regulation or methodology specifying how such impacts should be evaluated.

The Forest Service's Scenery Management System (SMS) is among the most comprehensive federal agency visual impact methodologies. There are no agency-specific methodologies for evaluating visual impacts on NPS or USFWS lands, although relevant NPS guidance is described below.



Source: USGS 2012

Figure 8.1.8-1: Areas in Puerto Rico Managed for Visual Resources

Forest Service Scenery Management System

The Forest Service SMS is described in the 1995 publication, *Landscape Aesthetics: A Handbook for Scenery Management* (*USDA 1995*). As stated in the SMS publication

> "[t]he system is to be used in the context of ecosystem management to inventory and analyze scenery in a national forest, to assist in establishment of overall resource goals and objectives, to monitor the scenic resource, and to ensure high-quality scenery for future generations." (*USDA 1995*)

The SMS process "involves identifying scenery components as they relate to people, mapping these components, and developing a value unit for aesthetics from the data gathered" (*USDA 1995*). The scenery components identified in the SMS include:

- Scenic Attractiveness: the distinctiveness of the landscape in question;
- Landscape Visibility: the ability of observers to see the landscape in question;
- Constituent Analysis: the importance of landscape aesthetics to those who view the landscape in question; and
- Distance Zones: the relative sensitivity of the landscape in question based on the distance from a typical observer.

Within each forest, the Forest Service maps scenery component values (i.e., showing the portions of the forest that fall into each gradation of scenic attractiveness or landscape visibility, etc.), and then uses that data to determine which of the seven Scenic Classes in the SMS best describes each area of within the forest.

> "Scenic classes measure the relative importance, or value, of discrete landscape areas having similar characteristics of scenic attractiveness and landscape visibility. Scenic classes are used during forest planning to compare the value of scenery with the value of other resources, such as timber, wildlife, old-growth, or minerals." (*USDA 1995*)

Scenic Classes are numbered from 1 to 7. "Generally Scenic Classes 1-2 have high public value, Classes 3-5 have moderate value, and Classes 6 and 7 have low value" (*USDA 1995*).

National Park Service

A NPS-authored guidance document for evaluating visual impacts associated with renewable energy projects (such as wind turbines) does provide an indication of the agency's approach to visual impact assessment. For NPS, visual impact assessment revolves primarily around the following concepts:

- Visual contrast: "the change in what is seen by the viewer" as a result of a new project such as a wind turbine (*Sullivan and Meyer 2014*); and

- Visual impact: "both the change to the visual qualities of the landscape resulting from the introduction of visual contrasts [i.e., a new wind turbine]…and the human response to that change" (*Sullivan and Meyer 2014*).

Visual impact assessments are incorporated into Environmental Impact Statements for units of the National Park System.

Federal Aviation Administration

Federal Aviation Administration (FAA) regulations in *14 CFR § 77* (commonly known as Part 77 regulations) require distinctive paint and lighting for structures with the potential to affect aerial navigation. Recommendations on marking and lighting structures may vary depending on terrain features, weather patterns, and geographic location. Guidance for implementing Part 77 regulations include (but are not limited to) the following (all citations from *FAA 2016*):

- Marking and/or lighting for any temporary or permanent structure, including all appurtenances, that exceeds an overall height of 200 feet above ground level (AGL) or exceeds any obstruction standard contained in the Part 77 regulations;
- Medium-intensity flashing white lights (daytime and twilight with automatically selected reduced intensity for nighttime) for structures greater than 200 feet AGL (other lighting and marking methods may be omitted for structures that do not exceed 700 feet AGL);
- Aviation orange and white paint for daytime marking on structures exceeding 700 feet AGL;
- High-intensity flashing white lights (daytime only with automatically selected reduced intensities for twilight and nighttime) for structures exceeding 700 feet AGL (other lighting and marking methods may be omitted if this system is used);
- Dual lighting including red lights for nighttime and high- or medium-intensity flashing white lights for daytime and twilight;
- Temporary high- or medium-intensity flashing white lights, as recommended in the determination, operated 24 hours a day during construction until all permanent lights are in operation;
- Red obstruction lights with painting or a medium-intensity dual system for structures 200 feet or more AGL in urban areas where there are numerous other white lights; and
- Steady red lighting for transmission wires (referred to in *FAA 2016* as catenary wires between transmission towers) near aviation facilities, canyons, and other areas.

In addition, the USFWS has drafted revised guidelines related to communication towers, designed to protect migratory birds (*USFWS 2013*).[1] Regarding visual conditions, the USFWS guidelines recommend that for new structures tall enough to require lighting under FAA Part 77 guidance

> "…the minimum amount of pilot warning and obstruction avoidance lighting required by the FAA should be used. Unless otherwise required by the FAA, only white strobe or red strobe lights (red preferable), or red flashing incandescent lights should be used at night, and these should be the minimum number, minimum intensity,…and minimum number of flashes per minute (i.e., longest duration between flashes/'dark phase') allowable by the FAA. The use of solid (non-flashing) warning lights at night should be avoided." (*USFWS 2013*)

National Scenic Rivers

Portions of three Puerto Rico rivers—all in the northeastern portion of the main island—are designated as National Scenic Rivers:

- A 1.2-mile segment of the Río de la Mina;
- A 2.3-mile segment of the Río Icacos; and
- A 1.4-mile segment of the Río Mameyes.

All three of these rivers are within the El Yunque National Forest and are managed by the Forest Service.

National Scenic Rivers are part of the National Wild and Scenic Rivers System, created by the National Wild and Scenic Rivers Act (*Pub. L. No. 90-542 [1968]*). The goal of the system is to

> "preserve certain rivers with outstanding natural, cultural, and recreational values in a free-flowing condition for the enjoyment of present and future generations. The Act is notable for safeguarding the special character of these rivers, while also recognizing the potential for their appropriate use and development." (*National Wild and Scenic Rivers System 2015*)

A river or segment of a river may be designated as wild, scenic, and/or recreational—the three designations are independent, although all may exist along the same reach. A national scenic river is "free of impoundments, with shorelines or watersheds still largely primitive and shorelines largely undeveloped, but accessible in places by roads" (*National Wild and Scenic Rivers System 2015*).

Designation under the National Wild and Scenic Rivers System makes the river and surrounding lands eligible to receive federal funding for land acquisition for the purpose of preservation. It also enables federal review of proposed projects along the banks of the designated river segment to ensure that such projects would not compromise the river's wild, scenic, and/or recreational qualities.

[1] See Chapter 11, BMPs and Mitigation Measures, for additional information regarding USFWS and FAA guidelines.

Commonwealth Lands

The Laws of Puerto Rico—the Commonwealth's compiled laws—do not include a general requirement for evaluation of visual or aesthetic impacts, nor do they contain general limitations on development to protect visual or aesthetic resources. Sections of the Laws of Puerto Rico related to territory forests, refuges, or other natural areas do not specifically discuss visual or aesthetic quality or impacts.

The Luis Muñoz Marin Scenic Route (Ruta Panorámica) is Puerto Rico's only designated scenic byway. It crosses the island from Mayagüez to Maunabo. The law establishing the route "authorize[s] the Puerto Rico Planning Board to adopt maps and regulations declaring as scenic zones the sides of the stretch of the 'Luis Muñoz Marín Scenic Route'" (*Laws of Puerto Rico § 22.31a-g*). No maps or regulations implementing this law were readily available. That Act also authorizes fundraising and management planning for the Scenic Route, although no such plans are readily available.

Local land development (i.e., zoning) ordinances provide some regulation of visual resources in Puerto Rico. Placement of telecommunications antennas and other structures requires approval of the Puerto Rico Planning Board. Co-location of multiple antennas on a single structure is encouraged (*Laws of Puerto Rico § 27.325*).

Local land development (i.e., zoning) ordinances typically provide some regulation of visual resources in Puerto Rico's cities. These ordinances often govern the appearance of development indirectly by regulating the type, height, bulk (i.e., how much of the lot a building can occupy, along with setbacks from front, side, and rear property lines), and density/intensity (i.e., number of housing units per acre or non-residential floor area ratio) of development.

8.1.8.3. Existing Visual Resources

Taken as a whole, Puerto Rico is known for its high scenic quality, particularly scenery associated with beaches, tropical forests, and historic resources (*USFS 2016; USFS 1997*). This section focuses on scenic resources that have been defined through the regulations and guidance described in Section 8.1.8.2, Specific Regulatory Considerations.

Federal Lands

Scenic resources on the federal lands in Puerto Rico are identified and managed by the host agency (in this case, the Forest Service, NPS, or USFWS) and codified in each agency's management document. These include the Land and Resource Management Plan for El Yunque National Forest (the Forest Plan) and Comprehensive Conservation Plans (CCPs) for the six National Wildlife Refuges (NWRs) in Puerto Rico. No General Management Plan for the NPS-managed San Juan National Historical Site is available.

The El Yunque Forest Plan states that the forest "contains some of the National Forest System's most scenic landscapes," and that "[t]he Forest's most prominent contrasts to the natural landscape are the electronic structures and security lighting located on El Yunque Peak and Pico Del Este" (*USFS 1997*). No inventory of scenery resources was completed for the existing

Forest Plan (adopted in 1998). The new Forest Plan (in development as of 2015) will include plan components that incorporate the SMS (*USFS 2015*).

NWRs and other USFWS lands are managed according to CCPs, Land Protection Plans, Monument Management Plans (for marine national monuments), or similar documents. While these documents may consider visual resources, they typically do not contain a visual impact assessment or policies specifically related to visual resources. The CCP for the Vieques NWR identifies scenic views and discusses a potential new scenic road (*USFWS 2007)*, and the CCP for the Cabo Rojo NWR states that "[t]he Puerto Rico Tourism Company believes that the scenic beauty and natural resources of the Cabo Rojo NWR…make this area of prime importance for the development of eco-tourism and nature tourism" (*USFWS 2011*). Other CCP documents generally acknowledge the scenic nature of NWRs in Puerto Rico; however, none of the USFWS management documents specifically evaluate visual conditions or impacts.

Commonwealth Lands

As described in Section 8.1.8.2, Specific Regulatory Considerations, the Commonwealth's laws generally acknowledge the importance of visual resources, but do not provide a methodology for evaluating visual impacts.

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8.1.9. Socioeconomics

8.1.9.1. Introduction

The National Environmental Policy Act of 1969 (NEPA; see Section 1.8, Overview of Relevant Federal Laws and Executive Orders) requires consideration of socioeconomics in NEPA analysis. Specifically, Section 102(A) of NEPA requires federal agencies to ensure "the integrated use of the natural and social sciences…in planning and in decision making" (*42 USC § 4332(A)*). Socioeconomics refers to a broad, social-science-based approach to understanding a region's social and economic conditions. It typically includes population, demographic descriptors, cultural conditions, economic activity indicators, housing characteristics, property values, and public revenues and expenditures. When applicable, it also includes qualitative factors such as community cohesion. Socioeconomics provides important context for analysis of FirstNet projects that could affect a region's socioeconomic conditions.

The choice of socioeconomic topics and depth of their treatment depends on the relevance of potential topics to the types of federal actions under consideration. FirstNet's mission is to provide a nationwide public safety broadband network (NPSBN) and interoperable emergency communications coverage. Relevant socioeconomic topics include population density and growth, economic activity, housing, property values, and territory and local taxes.

Environmental justice is a related topic that specifically addresses the presence of minority populations (defined by race and Hispanic ethnicity) and low-income populations, to give special attention to potential impacts on those populations per *Executive Order 12898* (see Section 1.8, Overview of Relevant Federal Laws and Executive Orders). Certain demographic information including race, ethnicity, age, income, and poverty status is also relevant to the evaluation of potential environmental justice issues, as discussed in the Environmental Justice Sections 8.1.10 and 8.2.10 in the Affected Environment and Environmental Consequences sections, respectively. This Final Programmatic Environmental Impact Statement (PEIS) also addresses the following topics, sometimes included within socioeconomics, in separate sections: infrastructure (Sections 8.1.1 and 8.2.1); land use, airspace, and recreation (Sections 8.1.7 and 8.2.7); and visual resources (Sections 8.1.8 and 8.2.8).

The financial arrangements for deployment and operation of the FirstNet network have socioeconomic implications. Section 1.1, Overview and Background, frames some of the public expenditure and public revenue considerations specific to FirstNet. This socioeconomics section provides some additional broad context, including data and discussion of territory and local government revenue sources that the Proposed Action could affect.

Wherever possible, this section draws on nationwide datasets from federal sources such as the United States Census Bureau (U.S. Census Bureau) and U.S. Bureau of Labor Statistics (BLS). This ensures consistency of data and analyses across the states and territories examined in this Final PEIS. In all cases, this section uses the most recent data available for each geographical location at the time of writing. At the county, state, territory, region, and United States levels, the data are typically for 2013 or 2014. For smaller geographic areas, this section uses data from the U.S. Census Bureau's American Community Survey (ACS). The ACS is the U.S. Census Bureau's flagship demographic estimates program for years other than the decennial census years. This Final PEIS uses the 2009-2013 ACS, which is based on surveys (population samples) taken across that 5-year period; thus, it is not appropriate to attribute its data values to a specific year. It is a valuable source because it provides the most accurate and consistent socioeconomic data across the nation at the sub-county level. Where available, information is presented at the national, territory, and county levels.

This section discusses existing socioeconomic conditions of Puerto Rico that could potentially be affected by deployment and operation of the Proposed Action, including the following subjects: regulatory considerations specific to socioeconomics in the territory, communities and populations, economic activity, housing, property values, and taxes.

8.1.9.2. Specific Regulatory Considerations

While subsistence harvesting of plant and animal[1] species may occur among some residents of Puerto Rico, research for this section did not identify any specific subsistence data or any territory, local, or tribal laws or regulations relevant to subsistence or any other socioeconomics topics for this Final PEIS.

8.1.9.3. Communities and Populations

Puerto Rico consists of 75 *municipios*, legal divisions that the U.S. Census Bureau treats as equivalent to counties.[2] Major population centers include the capital of San Juan, as well as the cities and surrounding areas of Bayamon, Carolina, Ponce, and Caguas (see Section 8.1.7, Land Use, Airspace, and Recreation). Table 8.1.9-1 presents population information for the territory, while Figure 8.1.9-1 shows this population distribution.

Table 8.1.9-1: National and Territory Population, Population Density, and Growth Rates

	2000	2010	2014	2014 Population Density (persons/sq. mi.)	Annual Growth Rate, 2000-2014[a]
United States	281,421,906	308,745,538	318,857,056	90.3	0.1%
Puerto Rico	3,808,610	3,725,789	3,548,397	1,036.4	-0.7%

Sources: U.S. Census Bureau 2000, 2010, 2014

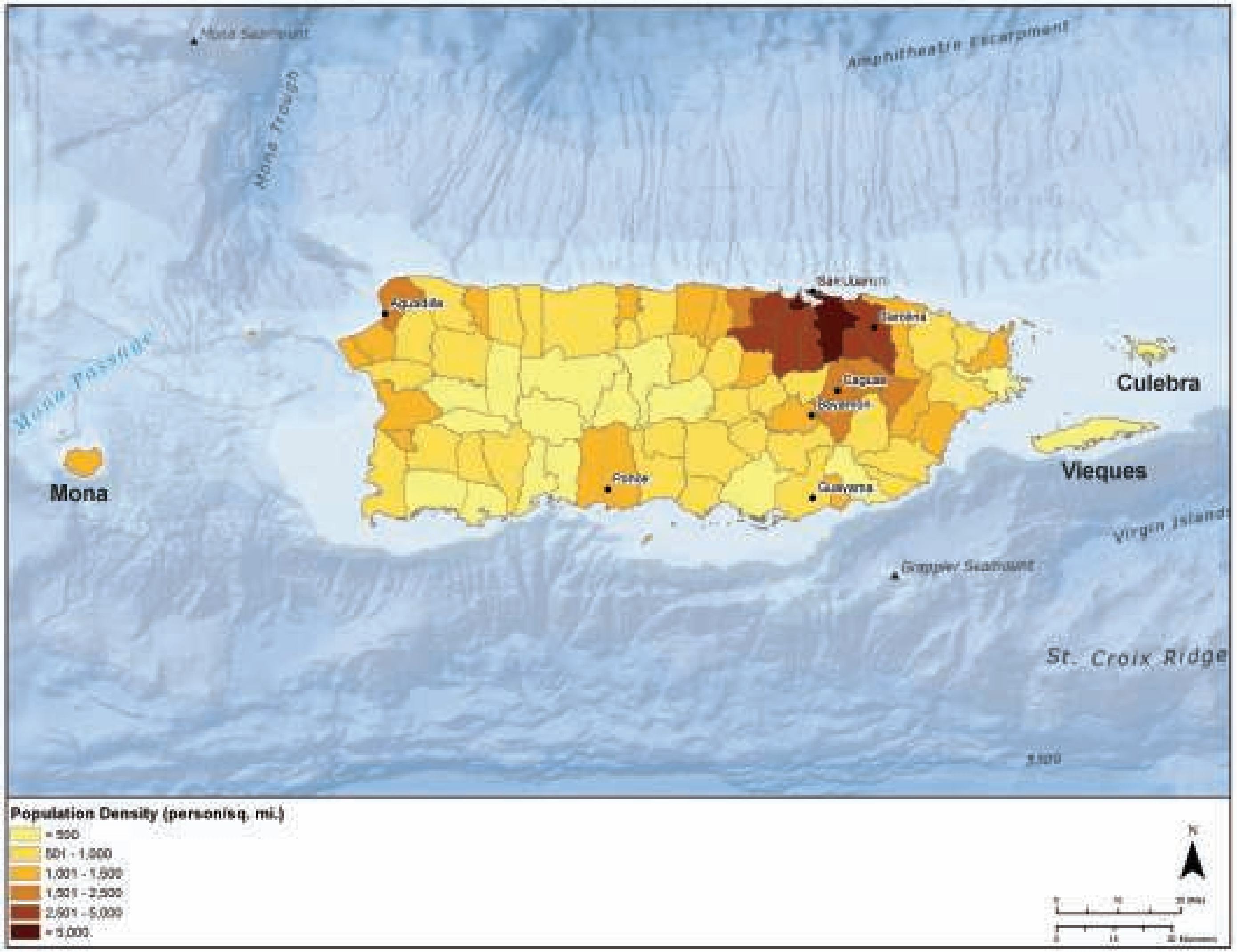
[a] Calculated using the standard growth rate formula (2014 population minus 2000 population divided by the 2000 population; that number was then divided by the number of years between 2000 and 2014 (14 years) to get the growth rate.

Population density is generally high throughout Puerto Rico. The U.S. Census Bureau has identified nine urban areas[3] in Puerto Rico, which account for approximately 45 percent of Puerto Rico's land area (*U.S. Census Bureau 2015*). In 2010, approximately 94 percent of the territory's population lived in urban areas, compared to approximately 81 percent of the national population (*U.S. Census Bureau 2010*).

[1] Harvesting of animal species is the act or process to take or kill wildlife for food, sport, or population control.

[2] The word *municipio* translates approximately to town; however, each *municipio* in Puerto Rico typically contains more than one settlement, and/or surrounding rural areas.

[3] Urban is defined as densely developed residential, commercial, and other non-residential areas (*U.S. Census Bureau 2015*).



Sources: U.S. Census Bureau 2000, 2010, 2014

Figure 8.1.9-1: Population Distribution and Density

As illustrated in Table 8.1.9-1, Puerto Rico has lost population since 2000, compared to a gradual increase in overall U.S. population. Population change in Puerto Rico *municipios* varies considerably from location to location. Larger population centers have all lost population, while only smaller *municipios* have gained population.

Table 8.1.9-2 shows population projections for Puerto Rico and the United States through 2040. Over this period of time, Puerto Rico's population is projected to continue to decline, although the rate of decline through 2040 is expected to slow.

Table 8.1.9-2: Population Projections

	2010	2020	2030	2040	Annual Growth Rate[a]
United States	308,745,538	335,605,444	360,978,449	382,152,234	0.8%
Puerto Rico	3,725,789	3,679,000	3,704,000	3,684,000	-0.1%

Sources: UVA 2015; United Nations 2012

[a] Calculated as described in footnote a of Table 8.1.9-1.

The analysis in Section 8.2.10, Environmental Justice, provides detailed race and ethnicity information for Puerto Rico and its census block groups.

8.1.9.4. Real Estate, Tax Revenues, Property Values, and Local Economic Activity

Economic Activity

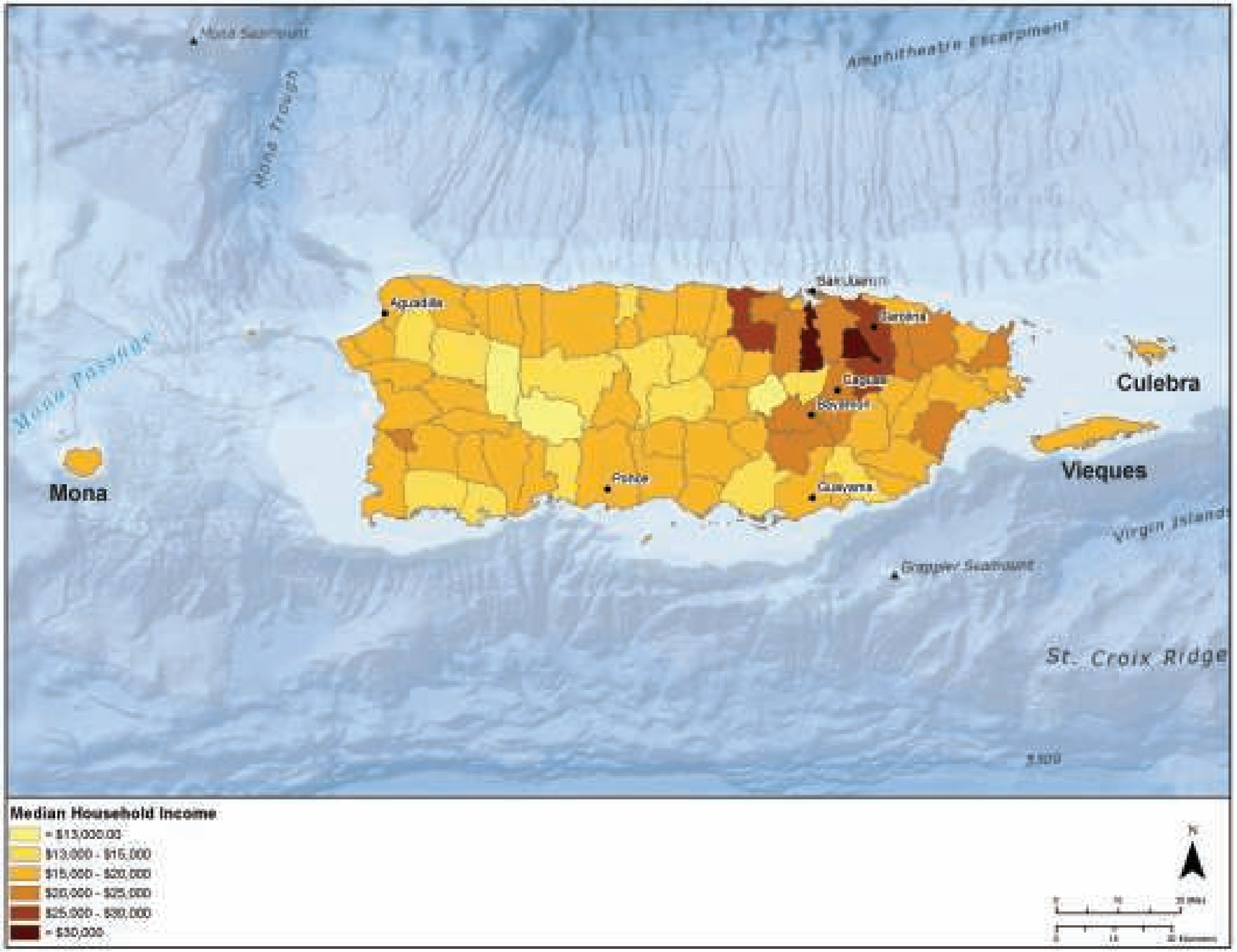
Over the previous 4 years, economic growth has been negative (*CIA 2015*). Once a largely agricultural-based economy, Puerto Rico's current economy is focused around industry and services (*Commonwealth of Puerto Rico 2015*). In particular, manufacturing provides nearly half of the Puerto Rico's gross domestic product. The services sector also provides approximately half of gross domestic product, along with approximately two-thirds of employment. Tourism (generally part of the service sector) is a major economic activity for Puerto Rico, contributing nearly $7.2 billion to Puerto Rico's economy (approximately 7.0 percent of total gross domestic product), and supported approximately 63,500 total jobs (approximately 6.1 percent of total employment) in 2013 (*World Travel and Tourism Council 2014*).

Table 8.1.9-3 summarizes selected economic indicators for Puerto Rico and the United States. Unemployment rates in Puerto Rico *municipios* (for the population age 16 and over) range from approximately 6 percent to more than 33 percent, with an average of 18.4 percent, compared to the national average of 9.7 percent in 2013, the most recent year for which data were available. Figure 8.1.9-2 shows the variation in median household income in Puerto Rico, while Figure 8.1.9-3 shows the variation in unemployment rate. Median household income in Puerto Rico is well below the national average. No single *municipio* has per capita or median household incomes at or above the national average.

Table 8.1.9-3: Select Economic Indicators, 2013

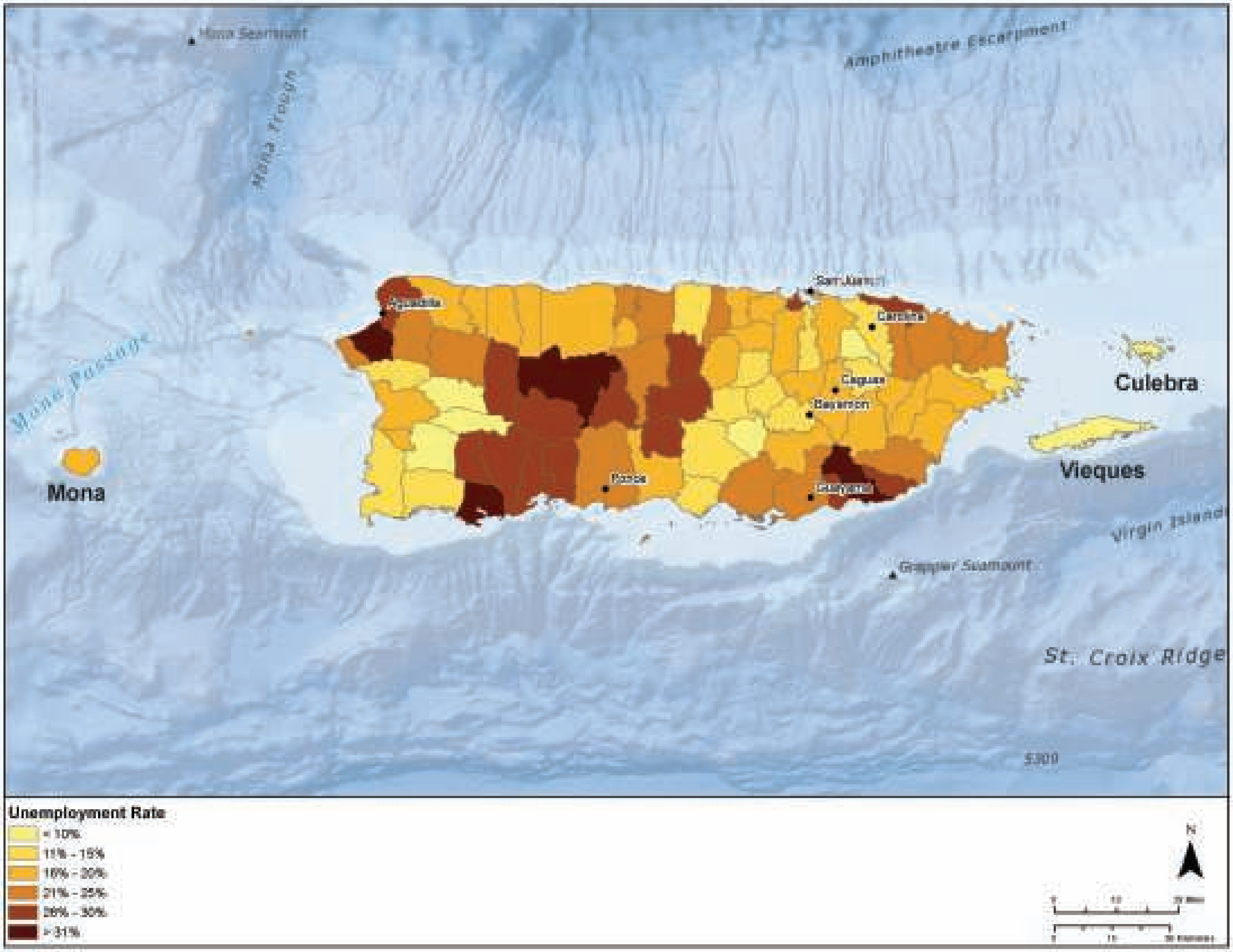
	Per Capita Personal Income	Median Household Income	Unemployment Rate
United States	$28,155	$53,046	9.7%
Puerto Rico	$11,068	$19,624	18.4%

Source: U.S. Census Bureau 2013



Source: U.S. Census Bureau 2013

Figure 8.1.9-2: Median Household Income



Source: U.S. Census Bureau 2013

Figure 8.1.9-3: Unemployment

Commercial, subsistence, and recreational fisheries in Puerto Rico contribute to the local economy and supply a valuable food source to the residents. In particular, commercial fishing provides many harvest and processing jobs for residents. The diverse marine environment in Puerto Rico also attracts eco-tourists such as divers, snorkelers, and underwater photographers. Other socioeconomic benefits related to these activities include recreational fishing guide operations, boat and SCUBA rentals, bait and tackle shops, lodging for tourists, and restaurants. Many ornamental species of freshwater and saltwater fish are collected for sale to aquarium hobbyists.

In addition to socioeconomic value, fish populations contribute a variety of fundamental services for maintaining ecosystem function and resilience, including regulating food web dynamics and nutrient balances (*Holmlund and Hammer 1999*).

Housing

Table 8.1.9-4 provides information on housing units, occupancy, and tenure (owner versus renter), while Table 8.1.9-5 provides information on housing costs. Between 2010 and 2013, Puerto Rico lost nearly 7 percent of its housing stock, while vacant housing units increased by nearly 13 percent. By comparison, the United States as a whole gained housing during the same period and saw vacancies increase by nearly 10 percent. These data in Puerto Rico are consistent with declining population and are likely a reflection of the weak global economy following the 2007 to 2008 recession.

The median value of a home in Puerto Rico in 2013 was $142,100, ranging from $83,500 to $204,500 in the territory's *municipios*. Population centers such as San Juan and Carolina generally had higher median home values than more rural parts of the territory. Between 2010 and 2013, both home values and rental costs increased in Puerto Rico, whereas home values decreased nationwide (while nationwide rents increased).

Table 8.1.9-4: Housing Units, Occupancy, and Tenure

	2010				2013				Change, 2010-2013			
	United States		Puerto Rico		United States		Puerto Rico		United States		Puerto Rico	
	Number	Pct.	Number	Pct.	Number	Pct.	Number	Pct.	Number	Pct.	Number	Pct.
Total:	131,704,730	100%	1,636,946	100%	132,057,804	1.00%	1,524,877	100%	353,074	0.3%	-112,069	-6.8%
Occupied	116,716,292	89%	1,376,531	84%	115,610,216	88%	1,230,868	81%	-1,106,076	-0.9%	-145,663	-10.6%
Owner-occupied	75,986,074	58%	986,165	60%	75,075,700	57%	862,880	57%	-910,374	-1.2%	-123,285	-12.5%
Renter-occupied	40,730,218	31%	390,366	24%	40,534,516	31%	367,988	24%	-195,702	-0.5%	-22,378	-5.7%
Vacant	14,988,438	11%	260,415	16%	16,447,588	13%	294,009	19%	1,459,150	9.7%	33,394	12.9%

Sources: U.S. Census Bureau 2010; U.S. Census Bureau 2013

Table 8.1.9-5: Housing Costs

	Median Home Value (Owner-Occupied)			Median Monthly Contract Rent (Renter-Occupied)		
	2010	2013	Change	2010	2013	Change
United States	$179,900	$176,700	-$3,200	$713	$733	$20
Puerto Rico	$120,300	$142,100	$21,800	$343	$354	$11

Sources: U.S. Census Bureau 2010; U.S. Census Bureau 2013

Property Values and Tax Revenues

Table 8.1.9-6 illustrates the median values of owner-occupied, single family homes in 2013 and their distribution across a range of prices. Figure 8.1.9-4 shows property values in Puerto Rico.

Table 8.1.9-6: Median Value of Owner-Occupied Single Family Homes, 2013

	Less than $50,000	$50,000 to $99,999	$100,000 to $149,999	$150,000 to $199,999	$200,000 to $299,999	$300,000 to $499,999	$500,000 or more
United States	6.1%	5.9%	8.7%	14.8%	32.9%	25.2%	6.3%
Puerto Rico	9.3%	27.4%	27.0%	18.4%	11.1%	4.7%	2.1%

Source: U.S. Census Bureau 2013

Changes in land value depend on factors such as the parcel size, proximity to public services, the parcel's current value and land use, and the value of nearby land parcels. Potential future buyers of land may also make decisions based on intended future use of land, as expressed in comprehensive land use plans or other local planning documents.

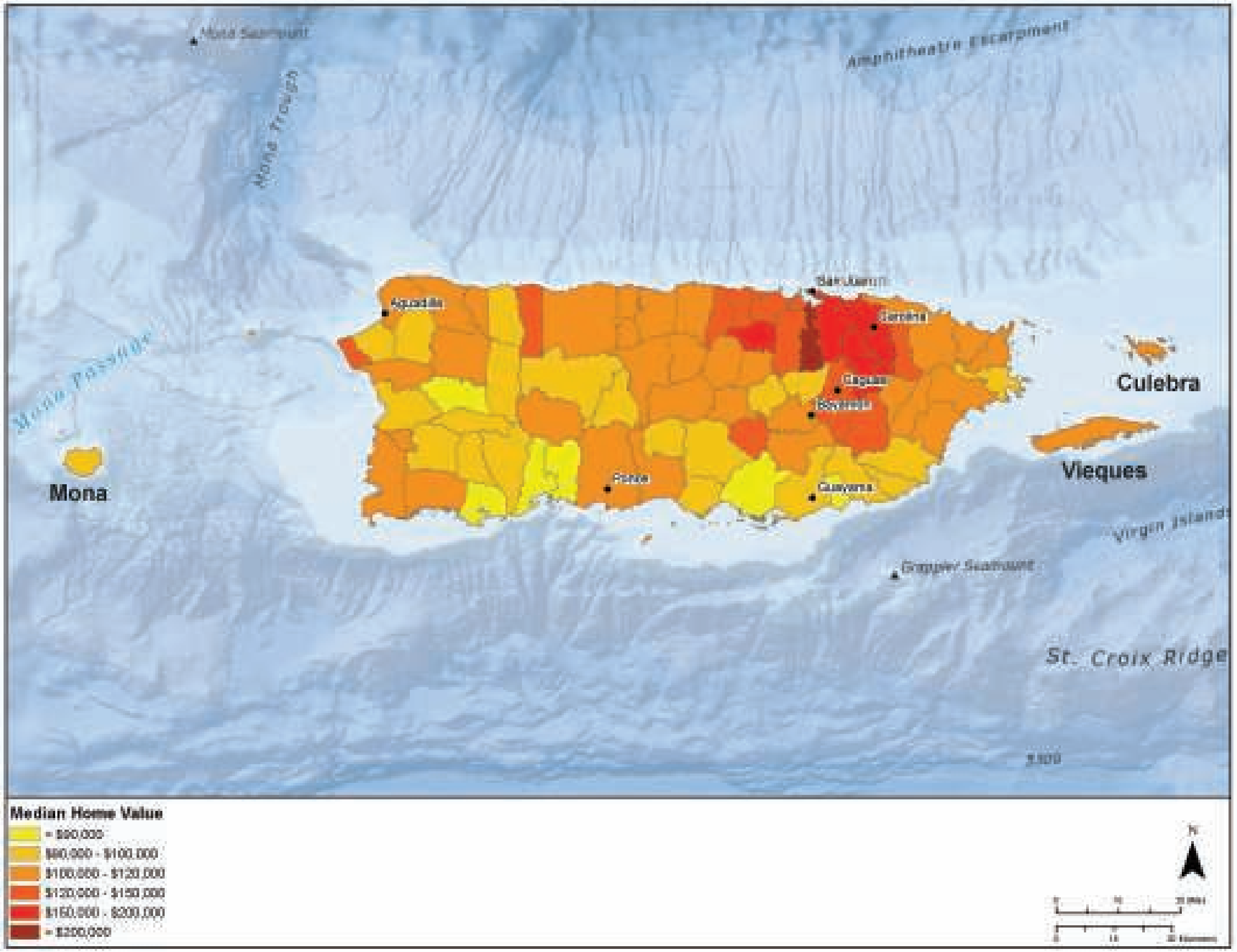
Table 8.1.9-7 lists the real estate taxes for owner-occupied housing units in Puerto Rico and its *municipios*. Landowners are responsible for property taxes levied against parcels based on the appraised value of their property, although more than 80 percent of residential property owners in Puerto Rico do not pay (and are presumably not assessed) any property tax.

Table 8.1.9-7: Real Estate Taxes, Owner-Occupied Units with a Mortgage, 2013

	Less than $800	$800 to $1,499	$1,500 or More	No Real Estate Taxes Paid	Median (dollars)
United States	13.2%	18.4%	66.2%	2.2%	$2,382
Puerto Rico	9.4%	4.0%	3.8%	82.8%	$716

Source: U.S. Census Bureau 2013

ND = no data



Source: U.S. Census Bureau 2013

Figure 8.1.9-4: Property Values

8.1.10. Environmental Justice

8.1.10.1. Introduction

This section presents select demographic data relevant to the assessment of environmental justice in Puerto Rico.[1] The United States (U.S.) Environmental Protection Agency (USEPA) defines environmental justice as "the fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income with respect to the development, implementation, and enforcement of environmental laws, regulations and policies" (*USEPA 2014b*). Environmental justice issues arise when minority or low-income groups experience disproportionately adverse health or environmental effects. The Council on Environmental Quality's (CEQ) document titled *Environmental Justice: Guidance Under the National Environmental Policy Act* clarifies that environmental effects include ecological, cultural, human health, economic, and social impacts (*CEQ 1997*).

Potential environmental justice issues associated with the Proposed Action are most likely to occur within the confines of a particular place and at a local level. Therefore, the information in this section is presented at the U.S. Census block group level, the smallest geographic unit for which demographic data are readily available. The U.S. Census Bureau describes block groups as statistical divisions of census tracts, generally containing between 600 and 3,000 people, and typically covering a contiguous area. Block groups do not cross state, county, or census tract boundaries, but may cross the boundaries of other geographic entities (*U.S. Census Bureau 2012*).

8.1.10.2. Specific Regulatory Considerations

Executive Order 12898, *Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations*, is the basis for environmental justice analysis and is discussed in Section 1.8, Overview of Relevant Federal Laws and Executive Orders.

The analysis of the potential impacts of the Proposed Action on environmental justice issues follows guidelines described in the *Environmental Justice: Guidance Under the National Environmental Policy Act* (*CEQ 1997*). The analysis method has three steps: 1) describe the geographic distribution of low-income and minority populations in the affected area; 2) assess whether the potential impacts of construction and operation would produce impacts that are high and adverse; and 3) if impacts are high and adverse, determine whether these impacts disproportionately affect minority and low income populations (*CEQ 1997*).

A description of the geographic distribution of minority and low-income groups in Puerto Rico was based on U.S. Census Bureau demographic data. The following definitions provided by the *Environmental Justice: Guidance Under the National Environmental Policy Act* (*CEQ 1997*) were used to identify minority and low-income population groups:

[1] A discussion of subsistence practices or resources is included in Section 8.1.9, Socioeconomics.

- Minority populations consist of individuals who are members of the following population groups: American Indian or Alaska Native, Asian or Pacific Islander, Black, some other race alone,[2] two or more races, or Hispanic; and
- Low-income populations consist of individuals living in poverty, as defined by the U.S. Census Bureau.

The U.S. Census Bureau has changed how it defines race and ethnicity. Ethnicity (Hispanic or Latino versus not Hispanic or Latino) is now defined differently from race (with race categories including White, Black or African American, American Indian or Alaska Native, Asian, and Native Hawaiian or Other Pacific Islander[3] (*OMB 1997*). As a result, this Final Programmatic Environmental Impact Statement (PEIS) considers both race and ethnicity separately for the purpose of evaluating minority status.

In 2014, the USEPA issued the *Policy on Environmental Justice for Working with Federally Recognized Tribes and Indigenous Peoples*, which establishes principles to ensure that achieving environmental justice is part of the USEPA's work with federally recognized tribes and Indigenous Peoples in all areas of the U.S. and its territories and possessions, the District of Columbia, Puerto Rico, and the Northern Mariana Islands, and others living in Indian country. The policy, which is based on Executive Order 12898 as well as USEPA strategic plan and policy documents, contains 17 principles pertaining to the policy's four focus areas. These four focus areas are:

- Direct implementation of federal environmental programs in Indian country and throughout the U.S.;
- Work with federally recognized tribes/tribal governments on environmental justice;
- Work with Indigenous Peoples (state-recognized tribes, tribal members, etc.) on environmental justice; and
- Coordinate and collaborate with federal agencies and others on environmental justice issues of tribes, Indigenous Peoples, and others living in Indian country.

The policy includes accountability for the implementation of the policy, a definitions section, and an appendix that contains a list of implementation tools available.

Research for this section of the Final PEIS did not identify any Puerto Rico-specific territorial, local, or tribal laws or regulations relevant to environmental justice. However, for permitting actions in Puerto Rico, the USEPA Region 2's Caribbean Environmental Protection Division (CEPD) incorporates the Region 2 environmental justice Action Plan elements into its permitting process and consults with the Region 2 Clean Air and Sustainability Division or Hazardous Waste Permitting Branch on an as-needed basis before finalizing permits (*USEPA 2014c*). The CEPD also ensures that all National Pollutant Discharge Elimination System permits requiring an environmental justice analysis follow the process established for Puerto Rico. For

[2] This definition includes all respondents who did not identify themselves as White, Black or African American, American Indian or Alaska Native, Asian, or Native Hawaiian or Other Pacific Islander race categories, or as an individual of multiple races.
[3] "Native Hawaiian or Other Pacific Islander" is an official U.S. Census Bureau category.

Puerto Rico, the CEPD focuses its Clean Water Act enforcement activities on communities, such as those surrounding the Martin Peña Channel, known to have environmental justice concerns. In addition, the CEPD developed a practice to use the Supplemental Environmental Projects enforcement mechanism to bring environmental protection and improvements to environmental justice communities of concern in Puerto Rico. This is done by promoting the use of Supplemental Environmental Projects among respondents of civil or administrative cases involving low-income communities (*USEPA 2014a*).

8.1.10.3. Minority and Income Status

Table 8.1.10-1 shows the race and ethnicity of Puerto Rico residents. Respondents to the U.S. Census may identify themselves as White, Black or African American, American Indian or Native Alaskan, Asian, Native Hawaiian and Other Pacific Islander, some other race alone, or a combination of these primary races. In Puerto Rico, 75.8 percent of residents identify themselves as white and 12.4 percent identify themselves as Black or African American, comparing similarly to 74 percent and 12.6 percent, respectively, in the nation as a whole. Nearly 8 percent of respondents in Puerto Rico identified themselves as some other race alone, compared to just 4.7 percent in the U.S. as a whole *(U.S. Census Bureau 2013)*.

Table 8.1.10-1: Race and Ethnicity, Puerto Rico

	Puerto Rico		**United States**	
Race	**Number**	**Percent**	**Number**	**Percent**
White	2,825,100	75.8%	230,592,579	74.0%
Black/African American	461,498	12.4%	39,167,010	12.6%
American Indian/Alaska Native	19,839	0.5%	2,540,309	0.8%
Asian	6,831	0.2%	15,231,962	4.9%
Native Hawaiian/Pacific Islander	370	0%	526,347	0.2%
Some other race alone	289,905	7.8%	14,746,054	4.7%
Multiple Races	122,246	3.3%	8,732,333	2.8%
Ethnicity				
Hispanic or Latino	3,688,455	99.0%	51,786,591	16.6%
Not Hispanic or Latino	37,334	1.0%	259,750,003	83.4%
Total	**3,725,789**		**311,536,594**	

Source: U.S. Census Bureau 2013

In the U.S. Census, ethnicity refers to being of Hispanic or Latino origin (or not Hispanic or Latino). Ethnicity is independent of race; a Hispanic individual may identify themselves as being of one or multiple races. As shown in Table 8.1.10-1, nearly all Puerto Ricans identify themselves as being Hispanic, compared to nearly 17 percent for the entire U.S.

Appendix E, *Environmental Justice Demographic Data*, provides demographic data characteristics for all block groups in Puerto Rico, including race, ethnicity, poverty status, and income. These data form the basis for the analysis of environmental consequences in Section 8.2.10, Environmental Justice.

8.1.10.4. Identification of Potential for Environmental Justice Impacts

Environmental justice impacts of the Proposed Action would most likely occur at a local level. For example, if adverse impacts from dust and noise exposure from construction of a communication tower, changes in property values, or effects from operation of communications equipment occur disproportionately in a specific environmental justice community (or communities), then these could constitute an environmental justice impact. Therefore, the environmental justice screening analysis in this Final PEIS uses the smallest geographic unit for which socioeconomic data are readily available, the census block group. In dense urban areas, a block group may only encompass a few city blocks. In rural areas, a block group may cover many square miles.

Because the specific location and deployment options of the Proposed Action have not been determined, this Final PEIS identifies locations in Puerto Rico where potential environmental justice impacts could be either more or less likely to occur. If the potential exists for environmental justice impacts from one or more aspects of the Proposed Action (such as noise, air quality, or visual impacts), additional analyses to identify environmental justice communities and assess specific impacts on those communities could be necessary as part of implementation. Site-specific analysis may be required depending on the site conditions, the type of deployment, or any other permits or permissions necessary to perform the work. The remainder of this section describes the methodology for making that determination.

The CEQ provides some basic guidance on the choice of metrics for classifying minority populations (i.e., environmental justice communities):

> "Minority populations should be identified where either: (a) the minority population of the affected area exceeds 50% or (b) the minority population percentage of the affected area is meaningfully greater than the minority population percentage in the general population or other appropriate unit of geographic analysis." (*CEQ 1997*)

The CEQ also states that "low-income populations in an affected area should be identified with the annual statistical poverty thresholds from the U.S. Census Bureau's Current Population Reports, Series P-60 on Income and Poverty" (*CEQ 1997*). Poverty thresholds are specific income levels that take into account factors such as family size. The federal government defines these levels annually for the nation. U.S. Census Bureau defines a "poverty area" as an area (in this case, a block group) where more than 20 percent of the population is at or under the poverty level (*Bishaw 2014*).

Beyond this guidance, many aspects of environmental justice impacts are discretionary and are matters of precedent and best practice within particular agencies and among socioeconomic analysts. The CEQ also does not define "meaningfully greater," nor does it define the "appropriate unit of geographic analysis" (per the quote above).

For the purpose of evaluating potential environmental justice impacts, the Final PEIS uses Puerto Rico's total population as the comparison group (the "general population or other appropriate unit" described in the quote above), hereafter called the reference population.

While "poverty" and "low-income" status are related, they are different terms. The Final PEIS defines a low-income household as one whose income is less than or equal to two times the federal poverty level. This approach aligns with the USEPA's approach to defining "low income" in its EJSCREEN mapping tool (*USEPA 2015*).

The Final PEIS evaluates the potential for environmental justice impacts along a spectrum, from low to high potential. The location along this spectrum is determined by the presence of one or more cases where the racial, ethnic, or low income characteristics of the block group's population is "meaningfully greater" than the reference population's characteristics. The Final PEIS defines "meaningfully greater" as meeting or exceeding one or more of the following thresholds:

1. An overall racial (non-white) or ethnic (Hispanic or Latino) minority population whose share of the block group's population is at least 20 percentage points greater than the reference population's minority percentage. This is the U.S. Department of Housing and Urban Development's definition of a "minority neighborhood" (*HUD Undated*).[4] For example, if 25 percent of the reference population is overall minority, the threshold applied to each block group for this criterion is 45 percent for overall minority population.
2. One or more individual racial or ethnic minority populations whose share of the block group's population is at least 20 percentage points greater than the reference population's comparable minority percentage. For example, if 25 percent of the reference population is an individual minority population, the threshold applied to each block group for this criterion is 45 percent for that individual minority population.
3. An overall racial or ethnic minority population whose share of the block group's population is at least 120 percent of the reference population's minority population.[5] For example, if 25 percent of the reference population is minority, the threshold applied to each block group for this criterion is 120 percent of 25 percent, or 30 percent.
4. The share of low-income residents (those with a household income equal to or less than two times the federal poverty level) in the block group is at least 120 percent of the reference population's low income level. For example, if 25 percent of the reference population is low income, the threshold applied to each block group is 30 percent.

Approximately 30 percent of Puerto Rico's population identifies itself as a racial minority (defined in this Final PEIS as a race other than white or Caucasian, not including Hispanic), while 99 percent of the population identify themselves as Hispanic. The same is true in a large proportion of Puerto Rico's block groups: "minority" residents—including Hispanic residents—comprise a sizeable majority of the population. As a result, the 50 percent threshold for race and ethnicity recommended by CEQ guidelines is not a meaningful criterion in Puerto Rico, and has

[4] Race (White, Black/African American, Asian, etc.) and ethnicity (Hispanic/Latino or not Hispanic/Latino) are separate categories, and are therefore considered separately as discussed above.
[5] Criteria 1 and 3 are similar, as are criteria 2 and 4. Both sets of criteria are based on federal and state environmental justice methodologies. Both sets of criteria are used here to ensure that the "meaningfully greater" term fully identifies communities where environmental justice impacts are possible.

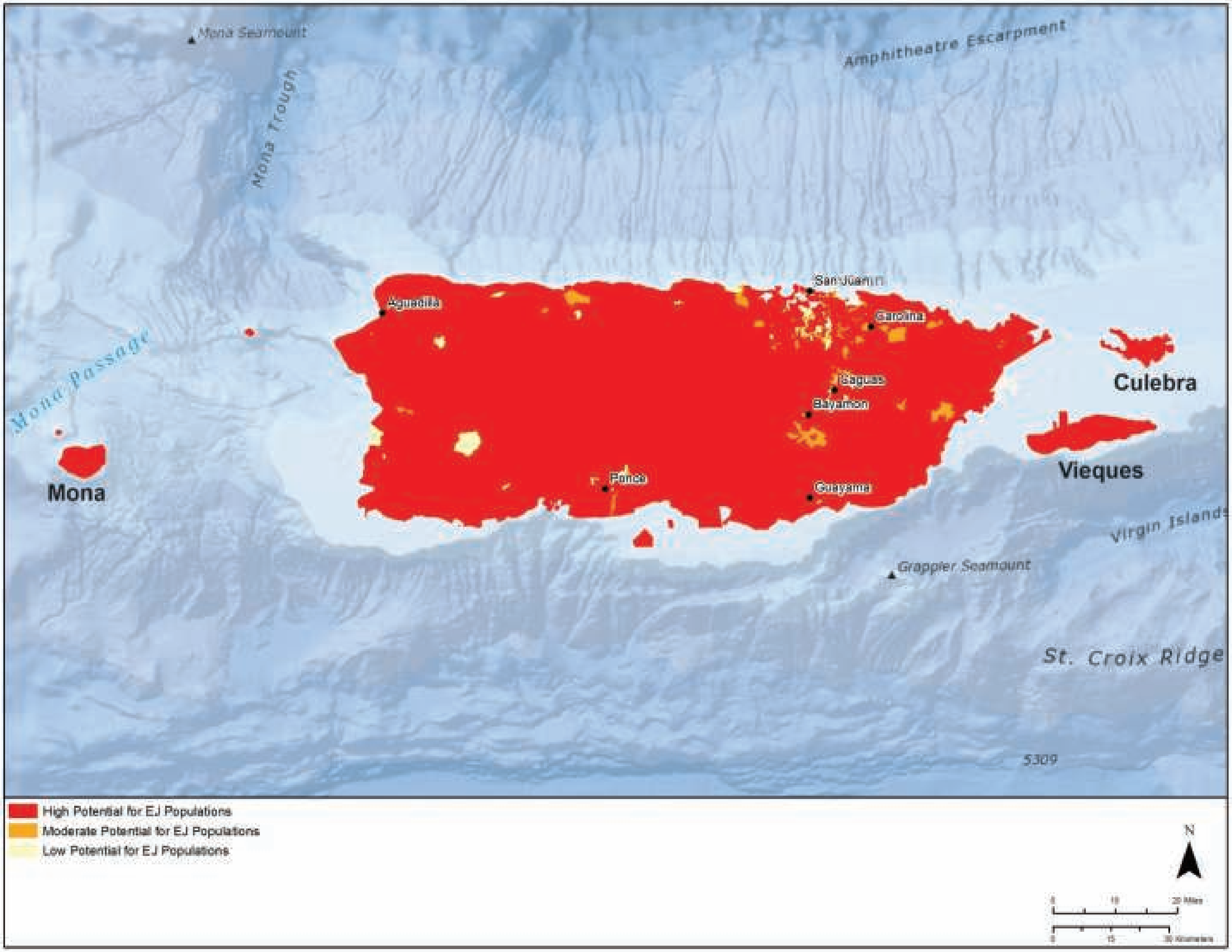
not been applied to Puerto Rico. Instead, the analysis of minority populations is based on the other thresholds described above.

The following combinations of the threshold characteristics listed above define three degrees of likelihood that a block group contains a potential environmental justice community:

- High Potential for Environmental Justice Communities
  - A poverty area, as defined by the U.S. Census (greater than 20 percent of the block group's total population living in poverty); or
  - At least one minority population whose percentage of the block group's total population is at least 20 percentage points higher than that minority's share of the reference population; or
  - The combined minority share of the block group's overall population (portion of the block group whose household income is no more than 200 percent of the poverty level) is at least 120 percent of the reference population's combined minority share. For example, if the combined minorities of the territory (reference area) equal 12 percent of the total territory population, then any block group where the combined minorities equal more than 14.4 percent of the block group's total population would potentially be a high risk.
- Moderate Potential for Environmental Justice Communities
  - Does not meet any of the above thresholds; and
  - At least one minority's share of the block group's overall population is at least 120 percent of that minority's share of the reference population; or
  - The low-income share of the block group's population (portion of the block group whose household income is no more than 200 percent of the poverty level) is at least 120 percent of the reference area's low income population share. For example, if a state's low-income population was 10 percent of the total population, then any block group where low-income residents equaled 12 percent or more of the block group's total population would potentially be a moderate risk.
- Low Potential for Environmental Justice Communities
  - Does not meet any of the above thresholds.

This Final PEIS applies this methodology to all block groups in the territory. Figure 8.1.10-1 displays the results of the screening analysis and shows the potential presence of environmental justice communities.

A substantial portion of Puerto Rico's block groups has a high potential for environmental justice communities, and therefore a high potential for impacts to those communities. These high-potential areas are found on all of Puerto Rico's populated islands and cover all or nearly all of the islands. Moderate- and low-potential block groups are only found on the largest island—Puerto Rico. Moderate- and low-potential block groups appear to generally be clustered near major population centers, such as San Juan, Carolina, Caguas, and Bayamon.



Source: U.S. Census Bureau 2013 (per the analysis described above)

Figure 8.1.10-1: Potential for Environmental Justice Populations

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8.1.11. Cultural Resources

8.1.11.1. Introduction

This section discusses cultural resources that are known to exist in Puerto Rico. For the purposes of this Final Programmatic Environmental Impact Statement (PEIS), cultural resources are defined as natural or manmade structures, objects, features, and locations with scientific, historic, and cultural value, including those with traditional religious or cultural importance, as well as any prehistoric or historic district, site, or building included in, or eligible for inclusion in, the National Register of Historic Places (NRHP).

This definition is consistent with how cultural resources are defined in:

- The statutory language and implementing regulations for Section 106 of the National Historic Preservation Act of 1966, as amended (NHPA), formerly *16 USC § 470a(d)(6)(A)* (now *54 USC § 306131(b)*) and *36 CFR § 800.16(l)(1)*;
- The statutory language and implementing regulations for the Archaeological Resources Protection Act of 1979, *16 USC § 470cc(c)* (now *54 USC § 3203*) and *43 CFR § 7.3(a)*;
- The statutory language and implementing regulations for the Native American Graves Protection and Repatriation Act, *25 USC § 3001(3)(D)* and *43 CFR § 10.2(d)*; and
- National Park Service's guidance for evaluating and documenting traditional cultural properties (TCPs)[1] (*NPS 1998*).

Information is presented regarding cultural resources that would be potentially sensitive to impacts from deployment and operation of the Proposed Action.

8.1.11.2. Specific Regulatory Considerations

The Proposed Action is considered an undertaking as defined in *36 CFR § 800*, the regulation implementing Section 106 of the NHPA (see Section 1.8.2, National Historic Preservation Act). The intent of Section 106, as set forth in its attending regulations, is for federal agencies to take into account the effects of a proposed undertaking on historic properties,[2] which can include TCPs, and to consult with the Advisory Council on Historic Preservation, federally recognized American Indian tribes[3] and Native Hawaiian organizations,[4] State Historic Preservation Offices

[1] TCP is defined as a place "eligible for inclusion in the NRHP because of its association with cultural practices or beliefs of a living community that (a) are rooted in that community's history, and (b) are important in maintaining the continuing cultural identity of the community" (*NPS 1998*).

[2] An historic property is defined in the NHPA as any "prehistoric or historic district, site, building, structure, or object included on, or eligible for inclusion on the National Register [of Historic Places (NRHP)], including artifacts, records, and material remains relating to the district, site, building, structure, or object" (*54 USC § 300308*). Further discussion of the use of this term for the purposes of this document is provided in Section 8.1.11.3, Cultural Setting.

[3] NHPA defines "Indian tribe" as "an Indian tribe, band, nation, or other organized group or community, including a Native village, Regional Corporation or Village Corporation (as those terms are defined in section 3 of the Alaska Native Claims Settlement Act (*43 USC § 1602*)), that is recognized as eligible for the special programs and services provided by the United States to Indians because of their status as Indians" (*54 USC § 300309*).

(SHPOs), local governments, applicants for federal assistance, permits, licenses, and other approvals, as well as any other interested parties with a demonstrated interest in the proposed undertaking and its potential effects on historic properties.

The Puerto Rico State Historic Preservation Office (PRSHPO, or *Oficina Estatal de Conservacion Historica* in Spanish) is responsible for the preservation and protection of cultural resources. As such, this agency is responsible for consultation with the Advisory Council on Historic Preservation, federal and other territory agencies, and territory residents regarding proposed undertakings under Section 106 and various other federal laws and regulations in Puerto Rico (see Section 1.8, Overview of Relevant Federal Laws and Executive Orders, and Appendix C, *Environmental Laws and Regulations*).

No specific territorial laws could be identified dealing with reburial or repatriation of prehistoric or historic human remains or an unmarked graves law. However, burials and human remains would be protected similarly as prehistoric or historic archaeological sites. If a burial is uncovered during development or construction, work must stop immediately in the area and local law enforcement should be notified. Following determination that the site does not constitute a crime scene and the remains are a prehistoric or historic human burial, the SHPO may assist the project proponent, developer, and/or landowner in contacting appropriate parties, considering options to avoid the burial(s), and advising on the legal process for potentially moving the remains.

Based on the federal laws and regulations discussed above, the Proposed Action requires FirstNet to seek the review, consultation, and concurrence of the PRSHPO prior to deployment. Federal agencies are required to consult with American Indian tribes and Native Hawaiian organizations as part of Section 106 and as part of other federal historic preservation laws; however, there are no federally recognized tribes in Puerto Rico. Although Section 106 and other federal policies and historic preservation laws require federal agencies to consult with American Indian tribes and Native Hawaiian organizations, consultation with native Puerto Rican groups is not required. However, many agencies, such as FirstNet, consult with native groups where they exist consistent with the intentions of these policies and laws to maintain open, collaborative relationships with native peoples throughout their projects and programs.

In accordance with the Council on Environmental Quality's guidance, entitled *NEPA and NHPA: A Handbook for Integrating NEPA and Section 106*, the NHPA Section 106 process is proceeding on a parallel path to the National Environmental Policy Act (NEPA) process.

[4] NHPA defines a Native Hawaiian organization as any organization which "serves and represents the interests of Native Hawaiians; has as a primary and stated purpose the provision of services to Native Hawaiians; and has demonstrated expertise in aspects of historic preservation that are culturally significant to Native Hawaiians. In this division, the term 'Native Hawaiian organization" includes the Office of Hawaiian Affairs of Hawaii and Hui Malama I Na Kupuna O Hawai'i Nei, an organization incorporated under the laws of the State of Hawaii" (*54 USC § 300314*). NHPA defines Native Hawaiian as "any individual who is a descendant of the aboriginal people who, prior to 1778, occupied and exercised sovereignty in the area that now constitutes Hawaii" (*54 USC § 300313*).

8.1.11.3. Cultural Setting

As discussed above, "cultural resources" is a general term that can include a wide range of resources. A Section 106 review commonly focuses on the identification of historic properties; however, historic properties are only a subset of cultural resources, and are but one aspect of the "human environment" as defined by NEPA regulations. The human environment, under NEPA, includes the natural and the physical (e.g., structures) environment, and the association of people and their activities to those environments. Therefore, a NEPA review must consider the cultural context in which potential project effects could occur. The intent of this section is to describe the affected environment within this cultural context.

Cultural Context

The history of Puerto Rico prior to European contact is based on a combination of ethnographic data, oral tradition, early historical documentation, and analysis of archaeological material.

Pre-Columbian Period (ca. 4000 BCE [Before Common Era] to 1493 CE [Common Era])

Archaeological studies and documentation of early Spanish explorers and chroniclers comprise the body of Puerto Rican pre-Columbian history. Sources including Christopher Columbus, Fray Bartolomé de las Casas, Gonzalo Fernández de Oviedo, Pedro Mártir de Anglería, and Fray Ramón Pané of Puerto Rico relate details of indigenous groups' daily life, religion and traditions, as well as early settlements at the time of initial contact with Europeans (*Garcia-Goyco 2014*).

Archaeological studies indicate that contemporary Puerto Rico was populated as early as the 4th millennium BCE by archaic or pre-agroceramic peoples arriving by raft or canoe from Belize, south of the Yucatan peninsula. These early groups fished, gathered, and hunted near mangrove swamps or coastal settlements. Social structures seem to have been organized by clan membership, and stone tool making for practical and ceremonial use was common (*Garcia-Goyco 2014*).

By 300 BCE, Arawak peoples with developed forms of agriculture and pottery-making arrived in Puerto Rico from Venezuela, settling in northeastern Puerto Rico along estuaries and coastlines. Archaeological findings indicate that Arawak peoples, who were organized in tribes, lived together in structures that housed entire communities. By 600 CE, a new group of people, called *Ostionians*, had evolved from Arawak groups on the island. Over a period of 300 years, Ostionian culture made the transition from tribal social systems to a political system headed by a chieftain (*Garcia-Goyco 2014*).

The Taino arrived last and were the dominant indigenous group on the island at the time of European contact. The Taino were an agricultural people politically organized into at least 24 chieftainships, or caciques, under a supreme cacique, according to documentation by Fernandez de Oviedo and Mártir de Anglería. It has been estimated that there may have been upwards of 100,000 Tainos living on Puerto Rico, then known as *Boriken* (or *Borinquen*), when Europeans first encountered them (*Garcia-Goyco 2014*).

Puerto Rico under the Spanish Empire (1493 to 1897)

In 1493, during Columbus' second voyage to the New World, he claimed what is now known as Puerto Rico for Spain, naming it San Juan Bautista. Later, in 1508, Juan Ponce de Leon, who had accompanied Columbus on his voyage, founded the first Spanish settlement on contemporary Puerto Rico with the permission of the Spanish Crown. Caparra became a mining and farming site on the north side of the island, governed by Juan Ponce de Leon (*NPS 1996*). A year later, the *repartimiento* system was established, whereby Spanish colonizers and authorities were provided a fixed number of Taino people, which they used as forced labor in mines and elsewhere (*NPS Undated*).

In 1511, impacts of European diseases and the repartimiento system on the local Taino population incited a rebellion, which the Spanish colonizers defeated. Ponce de Leon promptly ordered the execution of 6,000 Taino, effectively eliminating the local forced labor population. Two years later, in 1513, African slaves replaced the Taino in the island's gold mines. The mixing of the Spanish, Taino, and African peoples formed the ethnic and cultural foundation of Puerto Rico (*Garcia-Goyco 2014*).

In 1521, the settlement of Caparra was moved to a harbor island and renamed Puerto Rico. Eventually, this name extended to the island as a whole, and the port area became known as San Juan. By 1570, the gold mines exploited by Spanish colonizers were depleted, paving the way for an economic transition to agriculture and particularly sugar cane cultivation. This economic transition accompanied the establishment of townships throughout Puerto Rico (*PBS.org 2015*).

The strategic position of Puerto Rico as the gateway to the Indies made the island a hub for Spanish empire building efforts into the Americas. Over the course of centuries, other European states including England, the Netherlands, and France vied for control of Puerto Rico, but without success (*Garcia-Goyco 2014*).

Transition to U.S. Governance (1897 to Present)

In the 19th century, independence movements throughout Latin America inspired calls for autonomy within Puerto Rico. These efforts were unsuccessful until 1897, with the institution of the Carta Autonomica, which granted Puerto Rico a semi-autonomous government and status as a Spanish overseas province. The first semi-autonomous Puerto Rican government was elected and put into place a year later on July 17, 1898, months after the start of the Spanish-American war. Within 8 days, the United States (U.S.) military invaded Puerto Rico. General Nelson A. Miles, Commanding General of the U.S. Army, characterized advances into Puerto Rico thusly: "This is not a war of devastation, but one to give to all within the control of its military and naval forces the advantages and blessings of enlightened civilization" (*Herrmann 1907*). Less than a month later the war ended, and under the Treaty of Paris, the U.S was granted control of Puerto Rico (*Akiboh 2015*).

The ceding of Puerto Rico by the Spaniards to the U.S. did not bring calls for Puerto Rican independence to an end. Two notable voices among these were José Julio Henna and Manuel Zeno Gandia, Puerto Rican Commissioners, who protested being "under the military control of the freest country in the world" (*Henna and Gandia 1899*). Their advocacy highlighted the absence of Puerto Rican voices in negotiations between the U.S. and Spain, saying that "the island and its people were conveyed from one sovereign to another as a farm and its cattle are conveyed from a master to another" (*Henna and Gandia 1899*).

Both political and economic transition were, however, slow in coming. Not until the passage of the Jones-Shafroth Act in 1917 were Puerto Ricans afforded a number of constitutional rights, including U.S. citizenship. In 1952, Puerto Rico became a U.S. commonwealth, in the midst of major economic transition based on its sugar plantations to manufacturing and tourism activities, as American companies, attracted by business friendly tax laws and cheap labor, moved into Puerto Rico (*Akiboh 2015*).

Puerto Rico's political status is still debated, with proponents divided among eventualities of statehood, independence, or continued commonwealth status (*Smithsonian 2007*).

Archaeological and Historic Resources

The above sections provide a basis for understanding the identification and evaluation of cultural resources as they relate to the cultural context of Puerto Rico and the type of cultural resources that could exist within a project area of potential effect. Although site-specific information regarding cultural resources would need to be collected to define the affected environment of an individual project, the types of cultural resources that are currently listed on the NRHP across Puerto Rico can provide an understanding of the types and range of potential archaeological and historic resources that should be considered and could be affected by the Proposed Action.

As discussed above, "cultural resources" is a general term that can include a wide range of resources. For the purposes of brevity, the term "historic property" is used in this Final PEIS to refer to either historic properties, significant sites of religious and/or cultural significance, or traditional cultural properties. Table 8.1.11-1 provides a list of historic properties that have been evaluated and designated significant to be listed on the NRHP. There are currently 373 historic properties listed on the NRHP in Puerto Rico. The historic properties consist of archaeological sites and features; historic buildings and bridges; military sites, features, and objects; cemeteries; historic districts; shipwrecks; churches; and, cultural landscapes. Figure 8.1.11-1 shows the locations of the historic properties listed in Table 8.1.11-1.

Table 8.1.11-1: Historic Properties Listed on the NRHP

Property Name	Property Type	Municipios	City
Las Cabanas Bridge	Structure	Adjuntas	Adjuntas
Quinta Vendrell	Building	Adjuntas	Adjuntas
Washington Irving Graded School	Building	Adjuntas	Adjuntas
Puente de Coloso	Site	Aguada	Guanabano
Cardona Residence	Building	Aguadilla	Aguadilla
Casa de Piedra	Building	Aguadilla	Aguadilla
Church San Carlos Borromeo of Aguadilla	Building	Aguadilla	Aguadilla
District Courthouse	Building	Aguadilla	Aguadilla
El Parterre-Ojo De Agua	Site	Aguadilla	Aguadilla
Faro di Punta Borinquen	Structure	Aguadilla	Aguadilla

Property Name	Property Type	Municipios	City
Fuerte de la Conception	Building	Aguadilla	Aguadilla
Old Urban Cemetery	Site	Aguadilla	Aguadilla
Residence Lopez	Building	Aguadilla	Aguadilla
Silva-Benejan House	Building	Aguadilla	Aguadilla
Antiguo Casino Camuyano	Building	Aguadilla	Camuy
Hacienda La Sabana	Building	Aguadilla	Camuy
Church Nuestra Senora del Carmen of Hatillo	Building	Aguadilla	Hatillo
Hermitage of San Antonio de Padua de la Tuna	Site	Aguadilla	Isabela
Church San Juan Bautista of Maricao	Building	Aguadilla	Maricao
Puente Blanco	Structure	Aguadilla	Quebradillas
Parque de Bombas Maximiliano Merced	Building	Aguas Buenas	Aguas Buenas
Villa Julita	Building	Aibonito	Aibonito
Puente de Anasco	Structure	Anasco	Anasco
Calle Gonzalo Marin No. 61	Building	Arecibo	Arecibo
Cambalache Bridge	Structure	Arecibo	Arecibo
Casa Alcaldia de Arecibo	Building	Arecibo	Arecibo
Casa Cordova	Building	Arecibo	Arecibo
Casa de la Diosa Mita	Building	Arecibo	Arecibo
Casa Ulanga	Building	Arecibo	Arecibo
Corregimiento Plaza Theater	Building	Arecibo	Arecibo
Edificio Oliver	Building	Arecibo	Arecibo
Faro de Arecibo	Building	Arecibo	Arecibo
Gonzalo Marin 101	Building	Arecibo	Arecibo
La Casa de Los Soles Truncos	Building	Arecibo	Arecibo
National Astronomy and Ionosphere Center	District	Arecibo	Arecibo
Palacio del Marqués de las Claras	Building	Arecibo	Arecibo
Paseo Victor Rojas	Structure	Arecibo	Arecibo
Residencia Coll y Toste	Building	Arecibo	Arecibo
Church Nuestra Senora de la Candelaria y San Matias of Manati	Building	Arecibo	Manati
Mercado de las Carnes	Building	Arecibo	Ponce
Faro di Punta Higuero	Structure	Arecibo	Rincon
Church San Sebastian Martir of San Sebastian	Building	Arecibo	San Sebastian
Church San Miguel Arcangel of Utuado	Building	Arecibo	Utuado
Church Inmaculada Concepción of Vega Alta	Building	Arecibo	Vega Alta
Church Santa Maria del Rosario of Vega Baja	Building	Arecibo	Vega Baja
Panteon Otero-Martinez	Building	Arecibo	Vega Baja
Maceira, Rafael Balseiro, School	Building	Barceloneta	Barceloneta
Palo Hincado Site	Site	Barranquitas	Barranquitas
Casa Dr. Agustin Stahl Stamm	Building	Bayamon	Bayamon
Edificio Vela	Building	Bayamon	Bayamon
Farmacia Serra	Building	Bayamon	Bayamon
Marqués de la Serna Bridge	Structure	Bayamon	Bayamon

Property Name	Property Type	Municipios	City
Plata Bridge	Structure	Bayamon	Naranjito
Punta Ostiones	Site	Cabo Rojo	Cabo Rojo
Faro de los Morrillos de Cabo Rojo	Structure	Cabo Rojo	Pole Ojea
Aguayo Aldea Vocational High School	Building	Caguas	Caguas
Alcaldia de Caguas	Building	Caguas	Caguas
Benitez, Gautier, High School	Building	Caguas	Caguas
Logia Union y Amparo No. 44	Building	Caguas	Caguas
Primera Iglesia Bautista de Caguas	Building	Caguas	Caguas
Puente No. 6	Structure	Caguas	Caguas
Ernesto Memorial Chapel	Building	Camuy	Camuy
Villaran Bridge	Structure	Canovanas	Canovanas
Quebrada Maracuto	Site	Carolina	Carolina
Bacardi Distillery	District	Catano	Catano
Arenas Bridge	Structure	Cayey	Cayey
La Liendre Bridge	Structure	Cayey	Cayey
Rio Maton Bridge	Structure	Cayey	Cayey
Rodriguez Morales, Juana, House	Building	Cayey	Cayey
Ceiba Fire Station	Building	Ceiba	Ceiba
Manati Bridge at Mata de Platano	Structure	Ciales	Ciales
La Bolero	Building	Cidra	Cidra
Casa Blanca	Building	Coamo	Coamo
General Mendez Vigo Bridge	Structure	Coamo	Coamo
Hermitage Church of Nuestra Senora de Valvanera of Coamo	Building	Coamo	Coamo
Padre Inigo Bridge	Structure	Coamo	Coamo
Pomar, Pico, Residence	Building	Coamo	Coamo
Puente de las Calabazas	Structure	Coamo	Coamo
Cueva La Mora	Site	Comerio	Comerio
Rio Hondo Bridge	Structure	Comerio	Comerio
Mavilla Bridge	Structure	Corozal	Corozal
Faro Isla de Culebrita	Structure	Culebra	Culebra
Casa del Rey	Building	Dorado	Dorado
Hacienda de Carlos Vassallo	District	Dorado	Dorado
Martinez, Jacinto Lopez, Grammar School	Building	Dorado	Dorado
Punta Boca Juana	Site	Dorado	Dorado
Ramirez, Dona Antonia, Residencia	Building	Dorado	Dorado
Residencia Don Andres Hernandez	Building	Dorado	Dorado
SS ANTONIO LOPEZ Shipwreck Site and Remains	Site	Dorado	Dorado
US Custom House	Building	Fajardo	Fajardo
De Luxe Florida	Building	Florida	Florida
Faro de Guanica	Structure	Guanica	Guanica
Guanica Landing Site and Battlefield Historic District	District	Guanica	Guanica
Yauco Battle Site	Site	Guanica	Guanica
James Garfield Graded School	Building	Guanica	Guanica
Church San Jose of Aibonito	Building	Guayama	Aibonito

Property Name	Property Type	Municipios	City
Casa Natal de Luis Muñoz Rivera	Building	Guayama	Barranquitas
Church Nuestra Senora de la Asuncion of Cayey	Building	Guayama	Cayey
Casa Cautino	Building	Guayama	Guayama
Cayey Bridge	Structure	Guayama	Guayama
Eleuterio Derkes Grammar School	Building	Guayama	Guayama
Faro de Punta de la Tuna	Structure	Guayama	Guayama
Faro de Punta de las Figuras	Structure	Guayama	Guayama
Iglesia Parroquial de San Antonio de Padua de Guayama	Building	Guayama	Guayama
Ingenio Azucarero Vives	Site	Guayama	Guayama
Padre Nazario School	Building	Guayanilla	Guayanilla
Iglesia Parroquial de San Pedro Martir de Guaynabo	Building	Guaynabo	Guaynabo
Oficina de Telegrafo y Telefono	Building	Guaynabo	Guaynabo
Santuario de la Monserrate de Hormigueros and Casa de Peregrinos	Building	Hormigueros	Hormigueros
Silva Bridge	Structure	Hormigueros	Hormigueros
Torrens Bridge	Structure	Hormigueros	Hormigueros
Casa Marquez	Building	Hormigueros	Hormigueros
Llave 13	Site	Humacao	Barrio Llave, Vieques
Playa Grande 9	Site	Humacao	Barrio Llave, Vieques
Algodones 2	Site	Humacao	Barrio Puerto Diablo, Vieques
Algodones 3	Site	Humacao	Barrio Puerto Diablo, Vieques
Algodones 6	Site	Humacao	Barrio Puerto Diablo, Vieques
Loma Jalova 3	Site	Humacao	Barrio Puerto Diablo, Vieques
Monte Largo 2	Site	Humacao	Barrio Puerto Diablo, Vieques
Yanuel 8	Site	Humacao	Barrio Puerto Diablo, Vieques
Yanuel 9	Site	Humacao	Barrio Puerto Diablo, Vieques
Camp Garcia (Campo Asilo) 3	Site	Humacao	Barrio Puerto Ferro, Vieques
Punta Tapon	Site	Humacao	Barrio Puerto Ferro, Vieques
Le Pistolet	Site	Humacao	Barrio Punta Arenas, Vieques
Ventana 4	Site	Humacao	Barrio Punta Arenas, Vieques
Church Santiago Apostol of Fajardo	Building	Humacao	Fajardo
Church San Jose of Gurabo	Building	Humacao	Gurabo
Casa Roig	Building	Humacao	Humacao
Church Dulce Nombre de Jesus of Humacao	Building	Humacao	Humacao
Guzman Family Pantheon	Building	Humacao	Humacao

Property Name	Property Type	Municipios	City
Humacao Customs House	Building	Humacao	Humacao
Humacao District Courthouse	Building	Humacao	Humacao
Lopez de Pereyo, Palmira, House	Building	Humacao	Humacao
Rocafort, Salvador, Ice Plant	Building	Humacao	Humacao
Saez, Antonia, School	Building	Humacao	Humacao
Church Nuestra Senora del Rosario of Naguabo	Building	Humacao	Naguabo
Villa Del Mar	Building	Humacao	Naguabo
Nuestra Senora de las Mercedes de San Miguel de Hato Grande	Building	Humacao	San Lorenzo
Faro de Vieques	Building	Isabela	Isabel II
Fuerte de Vieques	Building	Isabela	Isabel II
La Piedra Escrita	Site	Jayuya	Jayuya City, Coabey Ward, Boqueron S
Cueva Lucero	Site	Juana Diaz	Juana Diaz
Gallardo, Jose Miguel, School	Building	Juncos	Juncos
Rivera, Luis Munoz, School	Building	Lajas	Lajas
Callejones Site	Site	Lares	Lares
Hacienda Los Torres	Building	Lares	Lares
de Hostos, Eugenio Maria, School	Building	Las Marias	Las Marias
Cueva del Indio	Site	Las Piedras	Las Piedra City
Cueva de Los Indios	Site	Loiza	Loiza
Pinones-Vacia Talega Archeological District	District	Loiza	Loiza
Parroquia del Espiritu Santo y San Patricio	Building	Loiza	Loiza Aldea
Williams Products Corporation	Building	Luquillo	Luquillo
Brunet-Calaf Residence	Building	Manati	Manati
Hacienda Azucarera la Esperanza	District	Manati	Manati
La Colectiva Tabacalera	Building	Manati	Manati
Plaza del Mercado de Manati	Building	Manati	Manati
Del Treinta Bridge	Structure	Maricao	Maricao
Hacienda Santa Rita	Building	Mayaguez	Guanica
Antiqua Residencia de la Familia Nadal	Building	Mayaguez	Mayaguez
Asilo De Pobres	Building	Mayaguez	Mayaguez
Baunin, Baldomero, Residence	Building	Mayaguez	Mayaguez
Casa Consistorial De Mayaguez	Building	Mayaguez	Mayaguez
Casino de Mayaguez	Building	Mayaguez	Mayaguez
Cementerio Municipal de Mayaguez	Site	Mayaguez	Mayaguez
Edificio Jose de Diego	Building	Mayaguez	Mayaguez
Esmoris, Duran, Residencia	Building	Mayaguez	Mayaguez
Fuentes, Ramirez, Residencia	Building	Mayaguez	Mayaguez
Gomez Residencia	Building	Mayaguez	Mayaguez
Isla de Mona	District	Mayaguez	Mayaguez
La Case Solariega de José De Diego	Building	Mayaguez	Mayaguez
Logia Adelphia	Building	Mayaguez	Mayaguez
Morales, Pardo, House	Building	Mayaguez	Mayaguez
Plaza Publica	Site	Mayaguez	Mayaguez
Residencia Bravo	Building	Mayaguez	Mayaguez

Property Name	Property Type	Municipios	City
Residencia Heyliger	Building	Mayaguez	Mayaguez
Residencia Heyliger (II)	Building	Mayaguez	Mayaguez
Residencia Ramirez De Arellano en Guanajibo	Building	Mayaguez	Mayaguez
Rivera, Nazario, Residencia	Building	Mayaguez	Mayaguez
Teatro Yaguez	Building	Mayaguez	Mayaguez
US Custom House	Building	Mayaguez	Mayaguez
US Post Office and Courthouse	Building	Mayaguez	Mayaguez
Faro de la Isla de la Mona	Structure	Mayaguez	Mona Island
Church of San Isidro Labrador and Santa Maria de la Cabeza of Sabana Grande	Building	Mayaguez	Sabana Grande
Casa de los Ponce de Leon	Site	Mayaguez	San German
Church San German Auxerre of San German	Building	Mayaguez	San German
Hacienda Buena Union	Site	Mayaguez	San German
Casa Franceschi Antongiorgi	Building	Mayaguez	Yauco
Casona Cesari	Building	Mayaguez	Yauco
Chalet Amill	Building	Mayaguez	Yauco
Filardi House	Building	Mayaguez	Yauco
Hacienda Iruena Manor House	Building	Moca	Aceitunas
Fontan, Jose, School	Building	Morovis	Morovis
Bridge No. 122	Structure	Naguabo	Naguabo
Escuela Guillermo Esteves	Building	Naranjito	Naranjito
Cueva La Espiral	Site	Orocovis	Orocovis
Semidey, Maria Davila, School	Building	Patillas	Patillas
Webster, Daniel, School	Building	Penuelas	Penuelas
Church San Blas de Illescas of Coamo	Building	Ponce	Coamo
Hacienda Buena Vista	District	Ponce	Corral Viejo
Church San Juan Bautista y San Ramon Nonato of Juana Diaz	Building	Ponce	Juana Diaz
Albergue Caritativo Tricoche	Building	Ponce	Ponce
Antiguo Cuartel Militar Español de Ponce	Building	Ponce	Ponce
Antiguo Hospital Militar Español de Ponce	Building	Ponce	Ponce
Armstrong-Toro House	Building	Ponce	Ponce
Banco Credito y Ahorro Ponceño	Building	Ponce	Ponce
Banco de Ponce	Building	Ponce	Ponce
Casa Alcaldia de Ponce-City Hall	Building	Ponce	Ponce
Casa de la Masacre	Building	Ponce	Ponce
Casa Paoli	Building	Ponce	Ponce
Casa Vives	Building	Ponce	Ponce
Casino de Ponce	Building	Ponce	Ponce
Castillo de Serralles	Building	Ponce	Ponce
Cathedral Nuestra Senora de Guadalupe of Ponce	Building	Ponce	Ponce
Cementerio Antiguo de Ponce	Site	Ponce	Ponce
Cementerio Catolico San Vicente de Paul	Site	Ponce	Ponce
Centro Ceremonial Indigena	Site	Ponce	Ponce

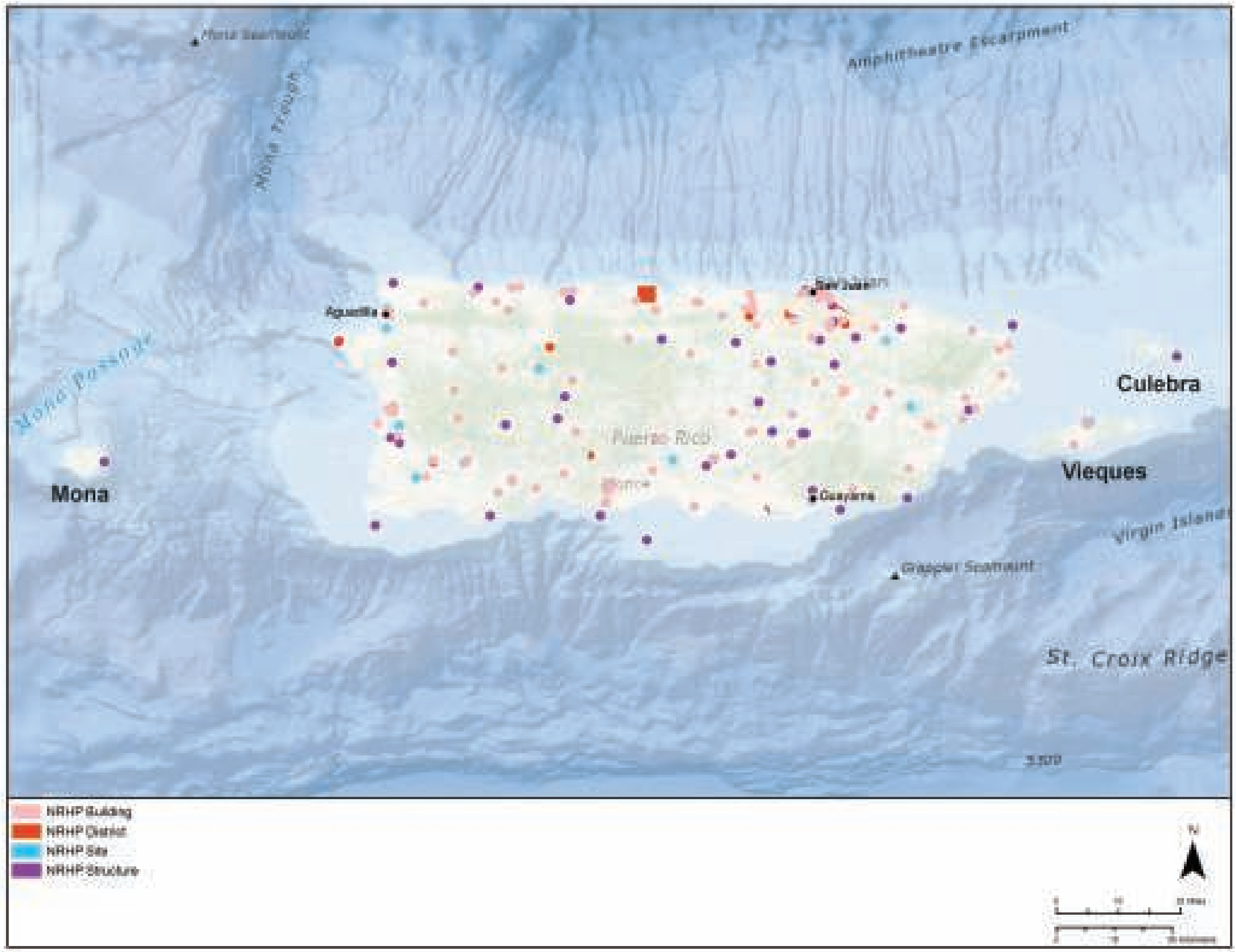
Property Name	Property Type	Municipios	City
Edificio Municipal de la Playa de Ponce	Building	Ponce	Ponce
Faro de la Isla de Caja de Muertos	Structure	Ponce	Ponce
Faro del Puerto de Ponce	Structure	Ponce	Ponce
Font-Ubides House	Building	Ponce	Ponce
Godreau, Miguel C., Casa	Building	Ponce	Ponce
Iglesia de la Santisima Trinidad	Building	Ponce	Ponce
McCabe Memorial Church	Building	Ponce	Ponce
Missionary Society of the Methodist Episcopal Church	Building	Ponce	Ponce
Nebot, Zaldo de, Residencia	Building	Ponce	Ponce
Oppenheimer House	Building	Ponce	Ponce
Parque de Bombas de Ponce	Building	Ponce	Ponce
Ponce High School	Building	Ponce	Ponce
Ponce YMCA Building	Building	Ponce	Ponce
Riera-Toro House	Building	Ponce	Ponce
Rosaly-Batiz House	Building	Ponce	Ponce
Salazar-Candal House	Building	Ponce	Ponce
Subira House	Building	Ponce	Ponce
Toro, Fernando Luis, Casa	Building	Ponce	Ponce
US Custom House	Building	Ponce	Ponce
Villaronga House	Building	Ponce	Ponce
Edificio Empresas Ferre	Building	Ponce	Ponce Playa
Rafael Rios Rey	Building	Ponce	Ponce Playa
Puente Rio Portugues	Structure	Ponce	Ponce
Teatro Liberty	Building	Quebradillas	Quebradillas
Boiling Nuclear Superheater (BONUS) Reactor Facility	District	Rincon	Rincon
Rio Grande Fire Station	Building	Rio Grande	Rio Grande
Cementerio Masonico de la Resp. Logia Igualdad Num. 23 de Sabana Grande	Site	Sabana Grande	Sabana Grande
Hacienda San Francisco	Building	Sabana Grande	Sabana Grande
Lassise-Schettini House	Building	Sabana Grande	Sabana Grande
Sepulveda, Berta, House	Building	Sabana Grande	Sabana Grande
James Fenimore Cooper Graded School	Building	Sabana Grande	Sabana Grande
Central Aguirre Historic District	District	Salinas	Salinas
Alcantarilla Pluvial sobre la Quebrada Manzanares	Structure	San German	San German
Convento de Porta Coeli	Building	San German	San German
Jaime Acosta y Flores Residence	Building	San German	San German
Perichi, Juan Ortiz, Casa	Building	San German	San German
San German Historic District	District	San German	San German
Casa Natal Dr. Jose Celso Barbosa	Building	San Juan	Bayamon
Church Santa Cruz of Bayamon	Building	San Juan	Bayamon
Puerto Rico National Cemetery	District	San Juan	Bayamon
Church of San Fernando of Carolina	Building	San Juan	Carolina
Edificio Alcaldia	Building	San Juan	Carolina
Caparra	Site	San Juan	Guaynabo

Property Name	Property Type	Municipios	City
Bithorn, Hiram, Municipal Stadium	Structure	San Juan	Hato Rey
House at 659 Concordia Street	Building	San Juan	Miramar
House at 659 La Paz Street	Building	San Juan	Miramar
House at 663 La Paz Street	Building	San Juan	Miramar
House at 665 McKinley Street	Building	San Juan	Miramar
US Post Office and Courthouse	Building	San Juan	Old San Juan
Biblioteca Carnegie	Building	San Juan	Puerta de Tierra
School of Tropical Medicine	Building	San Juan	Puerta de Tierra
Maternity Building	Building	San Juan	Rio Piedras
Puerto Rico Island Penitentiary	Building	San Juan	Rio Piedras
University of Puerto Rico Tower and Quadrangle	Building	San Juan	Rio Piedras
Acueducto de San Juan	District	San Juan	San Juan
Antiguo Casino de Puerto Rico	Building	San Juan	San Juan
Ateneo Puertorriqueño	Building	San Juan	San Juan
Carcel de Puerta de Tierra	Building	San Juan	San Juan
Casa de Espana	Building	San Juan	San Juan
Casa Dra. Concha Melendez Ramirez	Building	San Juan	San Juan
Casa Klumb	Building	San Juan	San Juan
Cementerio Santa Maria Magdalena de Pazzis	Site	San Juan	San Juan
Church, School, Convent and Parish House of San Agustin	Building	San Juan	San Juan
Colegio de las Madres del Sagrado Corazón	Building	San Juan	San Juan
Condado Vanderbilt Hotel	Building	San Juan	San Juan
Distrito Historico del Viejo San Juan-Old San Juan Historic District	District	San Juan	San Juan
Edificio Aboy	Building	San Juan	San Juan
Edificio del Valle	Building	San Juan	San Juan
Edificio Moragon	Building	San Juan	San Juan
Edificio Patio Español	Building	San Juan	San Juan
Edificio Victory Garden	Building	San Juan	San Juan
El Capitolio de Puerto Rico	Building	San Juan	San Juan
El Falansterio de Puerta de Tierra	District	San Juan	San Juan
Escuela Brumbaugh	Building	San Juan	San Juan
Escuela Graduado Jose Celso Barbosa	Building	San Juan	San Juan
Escuela Jose Julian Acosta	Building	San Juan	San Juan
Faro de Morro	Structure	San Juan	San Juan
Figueroa Apartments	Building	San Juan	San Juan
Fortin de San Geronimo de Boqueron	Site	San Juan	San Juan
General Norzagaray Bridge	Structure	San Juan	San Juan
Gran Logia Espiritual Numero 1	Building	San Juan	San Juan
Hotel Normandie	Building	San Juan	San Juan
La Fortaleza	Building	San Juan	San Juan
La Giralda	Building	San Juan	San Juan
Linea Avanzada	District	San Juan	San Juan
Martin Pena Bridge	Structure	San Juan	San Juan

Property Name	Property Type	Municipios	City
Old San Juan Historic District/Distrito Historico del Viejo San Juan NHL	District	San Juan	San Juan
Puerto Rico Ilustrado-Edificio El Mundo	Building	San Juan	San Juan
Residencia Luis Munoz Marin	District	San Juan	San Juan
Rio Piedras Bridge	Structure	San Juan	San Juan
Rivera, Luis Munoz, Park	Site	San Juan	San Juan
Rum Pilot Plant	Building	San Juan	San Juan
San Antonio Railroad Bridge	Structure	San Juan	San Juan
San Juan National Historic Site	District	San Juan	San Juan
Superintendent of Lighthouses' Dwelling	Building	San Juan	San Juan
Supreme Court Building	Building	San Juan	San Juan
US Custom House	Building	San Juan	San Juan
Administration Building	Building	San Juan	Santurce
Central High School	Building	San Juan	Santurce
Church of San Mateo de Cangrejos of Santurce	Building	San Juan	Santurce
Miami Building	Building	San Juan	Santurce
Nuestra Senora de Lourdes Chapel	Building	San Juan	Santurce
Polvorin de Miraflores	Building	San Juan	Santurce
Rafael M. Labra High School	Building	San Juan	Santurce
Residencia Aboy-Lompre	Building	San Juan	Santurce
Faro de las Cabezas de San Juan	Structure	San Juan	Soroco
Church Nuestra Senora de la Concepcion y San Fernando of Toa Alta	Building	San Juan	Toa Alta
Villa Victoria	Building	San Juan	San Juan
Residencia Machin-Ramos	Building	San Lorenzo	San Lorenzo
Brumbaugh, Dr. Martin G., Graded School	Building	Santa Isabel	Santa Isabel
Iglesia Parroquial de San Pedro Apostol de Toa Baja	Building	Toa Baja	Toa Baja
Santa Elena Hacienda	Building	Toa Baja	Toa Baja
Puente de Trujillo Alto	Structure	Trujillo Alto	Trujillo Alto
Bateyes de Vivi	Site	Utuado	Utuado
Blanco Bridge	Structure	Utuado	Utuado
Caguana Ceremonial Ball Courts Site	Site	Utuado	Utuado
19th Century Civil Architecture in Ponce	Building/Structure	Various	Various
Ball Court/Plaza Sites of Puerto Rico and the U.S. Virgin Islands	Structure	Various	Various
Cemeteries in Puerto Rico, 1804-1920	Site	Various	Various
Cockfighting in Puerto Rico	Building/Site/Structure	Various	Various
Early 20th Century Schools in Puerto Rico	Building	Various	Various
Early Prototypes for Manufacturing Plants in Puerto Rico, 1948-1958	Building/Structure	Various	Various

Property Name	Property Type	Municipios	City
Early Twentieth Century Schools in Puerto Rico	Building	Various	Various
Fire Stations in Puerto Rico	Building	Various	Various
Historic Bridges of Puerto Rico	Structure	Various	Various
Historic Churches of Puerto Rico	Building	Various	Various
Lighthouse System of Puerto Rico	Building	Various	Various
New Deal Era Constructions in the Forest Reserves in Puerto Rico	Building/Site/Structure	Various	Various
Prehistoric Rock Art of Puerto Rico	Site	Various	Various
Rum Industry in Puerto Rico	Building/Site/Structure	Various	Various
Spanish-American War in Puerto Rico	Building/Site/Structure	Various	Various
United States Custom Houses in Puerto Rico	Building	Various	Various
Casa Alonso	Building	Vega Baja	Vega Baja
Paso del Indio Site	Site	Vega Baja	Vega Baja
Central Playa Grande	Site	Vieques	Barrio Llave, Vieques
Paramayon 2	Site	Vieques	Barrio Llave, Vieques
Ventana Archeological District	Site	Vieques	Barrio Llave, Vieques
Laguna Jalova Archeological District	District	Vieques	Barrio Puerto Diablo, Vieques
Punta Jalova	Site	Vieques	Barrio Puerto Diablo, Vieques
Playa Vieja	Site	Vieques	Barrio Punta Arenas, Vieques
Resolucion Historic District	Site	Vieques	Barrio Punta Arenas, Vieques
Hacienda Casa del Frances	Building	Vieques	Esperanza
Acevedo, Rafael, House	Building	Vieques	Isabel Segunda
Casa Alcaldia de Vieques	Building	Vieques	Isabel Segunda
Casa Augusto Delerme	Building	Vieques	Isabel Segunda
Casa de Jaime Puig Lemoine	Building	Vieques	Isabel Segunda
Casa Delerme-Anduze No. 2	Building	Vieques	Isabel Segunda
Delerme-Anduze House	Building	Vieques	Isabel Segunda
Las Tumbas de J. J. Maria le Guillou	Site	Vieques	Isabel Segunda
Smaine-Ortiz House	Building	Vieques	Isabel Segunda
Vieques Pharmacy	Building	Vieques	Isabel Segunda
Jones, Walter Mc K., School	Building	Villalba	Villalba
Yabucoa Fire Station	Building	Yabucoa	Yabucoa
Casa Agostini	Building	Yauco	Yauco
Logia Masonica Hijos de la Luz	Building	Yauco	Yauco
Residencia Gonzalez Vivaldi	Building	Yauco	Yauco
Teatro Ideal	Building	Yauco	Yauco

Source: Stutts 2014



Source: Stutts 2014

Notes: Some of the historic properties listed in Table 8.1.11-1 have sensitive locations (e.g., archaeological sites) and are not shown here.

Figure 8.1.11-1: Historic Properties Listed on the NRHP

In addition to those listed on the NRHP, other known and unknown cultural resources exist across Puerto Rico that have yet to be identified or evaluated for their significance. A cultural resources survey would need to be conducted to identify specific cultural resources of an individual project; however, through previous surveys and a general understanding of the cultural context, archaeological sites and historic resources are more typically found in certain locations given their size, type, and function.

Archaeological site potential is largely based on an area's habitation suitability, proximity to natural resources, and/or locational prominence/importance. For instance, habitation sites, both prehistoric and historic, are typically found in naturally protected, upland landforms close to a significant and consistent fresh water source and within proximity to food resources. However, habitation sites can vary based on seasonal considerations or be temporal based on their use as specific resource extraction locations, recognizing that environmental conditions may have changed over time. Proximity to resources can vary according to a combination of environmental conditions such as the size and nature of the water source (perennial versus intermittent) and/or extent and location of food sources. Topographic prominence is also often indicative of archaeological potential. Topographically prominent locations were likely desirable locations as they provided vantage points for observation, which would be useful for tracking wildlife or recognizing potential threats to the habitation site. The presence of an extractive resource can also raise the potential for archaeological sites in a given location. Large outcrops of preferred stone resources, for example, are often the location of quarry sites; in another example, wood or other structural building resources would be expected in heavily forested areas. Likewise, topographic prominence could be an important component of ceremonial or spiritual sites or cultural landscapes.

In Puerto Rico, archaeological sites dating to the early Pre-Columbian Period are generally small and located on or near the coast (generally on low terraces above beaches) due to a reliance on fish, shellfish and sea mammals. As resource exploitation became more specialized, settlement patterns changed with sites strategically located near mouths of rivers, and at the edge of forests to take advantage of various types of resources at these locations; however, sites remain the same size. As populations started experimenting with agricultural practices in later periods, sites appear larger in size and located in greater abundance inland, nearer large tracts of flat land (*Alegria 1965; Rouse 1992*). At this time, sociopolitical organization and economic diversity is noted at sites. Sites size continues to grow and with it complexity and diversity. Ritual and ceremonial sites are noted in later Pre-Columbian periods and sites can be found in coastal environments, inland, and in more remote and/or mountainous locations. This type of site distribution is consistent with that at the time of European contact (*Faber Morse 1999; Rouse 1992*). Spanish Period sites would be consistent with that of a more commercial agricultural system with larger town sites with military fortifications, rural homesteads, and archaeological sites related to larger agricultural practices.

Traditional Cultural Properties and Cultural Resources of Traditional Religious or Cultural Importance

Traditional cultural properties and other cultural resources of traditional religious or cultural importance can include a wide range of tangible and intangible resources (e.g., archaeological sites and funerary objects, ceremonial places, traditional wildlife and plant gathering areas, and cultural landscapes). Section 106 consultation would provide the means of identifying the affected environment of these types of resources for an individual project (*NPS 1998*). Since there is no federally recognized native Puerto Rican group like that of an American Indian tribe or Native Hawaiian organization under Section 106, the public scoping and comment processes are one of the ways for FirstNet to learn of concerns from other distinct cultural groups regarding traditional cultural properties.

It is often difficult, if not impossible, to place strict boundaries on locations of traditional significance. Another complicating factor is that even when boundaries might be defined, members of cultural groups may not be willing to disclose such information to those outside of their communities for a number of reasons. Therefore, cultural sensitivity is needed to ensure protection of these important places (*ACHP 2008*). Types of traditional resources may include, but are not limited to, archaeological sites, burial sites, ceremonial sites, traditional hunting, fish ponds, and plant gathering areas, trails, certain prominent geological features that may have spiritual significance (i.e., cultural landscapes), and viewsheds to and/or from sacred locations (*NPS 1998*).

Whereas traditional cultural properties are historic properties (they are eligible for listing in the NRHP), other cultural resources of traditional religious or cultural importance need to be considered as they are important to a community's practices and beliefs and are necessary for maintaining the community's cultural identity. FirstNet plans to continue to work with the PRSHPO and interested Puerto Rican groups as part of the NHPA and NEPA processes. Although specific locations of many traditional cultural properties and other cultural resources of traditional religious or cultural importance in Puerto Rico are not currently known, FirstNet will maintain open, collaborative relationships with interested Puerto Rican groups throughout the NHPA consultation process for all cultural groups to ensure their consideration.

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8.1.12. Air Quality

8.1.12.1. Introduction

This section discusses the existing air quality conditions in Puerto Rico. Information is presented regarding air quality characteristics that would be potentially sensitive to impacts from deployment and operation of the Proposed Action. Air quality in a geographic area is determined by the type and amount of pollutants emitted into the atmosphere, the size and topography[1] of the area, and the prevailing weather and climate conditions. The levels of pollutants and pollutant concentrations in the atmosphere are typically expressed in units of parts per million (ppm)[2] or micrograms per cubic meter ($\mu g/m^3$) determined over various periods of time. The United States (U.S.) Environmental Protection Agency (USEPA) designates areas within the U.S. as attainment,[3] nonattainment,[4] maintenance,[5] or unclassifiable[6] depending on the concentration of air pollution relative to ambient air quality standards.

8.1.12.2. Specific Regulatory Considerations

Air quality and emissions of atmospheric pollutants are regulated under the Clean Air Act (CAA). The CAA establishes limits on how much air pollution can exist in an area at any given time, based on local climatological factors. These limits are known as the National Ambient Air Quality Standards (NAAQS). The USEPA has established NAAQS for six common pollutants, known as criteria pollutants. These include carbon monoxide, lead, nitrogen dioxide, ozone, particulate matter (PM), and sulfur dioxide (*USEPA 2013d*). Local air quality protection and permitting in Puerto Rico is jointly the responsibility of the Puerto Rico Environmental Quality Board and USEPA Region 2 (*USEPA 2014c*; *USEPA 2014b*). These agencies enforce the federal NAAQS within Puerto Rico. No information was readily available regarding enforcement of any Territory Ambient Air Quality Standards (TAAQS). Throughout this section, the term AAQS (ambient air quality standards) is used to refer to the NAAQS and TAAQS. Table 8.1.12-1 summarizes the NAAQS, which represents the TAAQS in Puerto Rico.

[1] Topography is the unique features and shapes of the land (e.g., valleys and mountains).

[2] One ppm is equivalent to 1 milligram per liter.

[3] Attainment areas meet the national primary or secondary ambient air quality standard for the pollutant (*USEPA 2015d*).

[4] Nonattainment areas do not meet (or contribute to ambient air quality in a nearby area that does not meet) the national primary or secondary ambient air quality standard for the pollutant (*USEPA 2015d*).

[5] Maintenance areas are areas that were previously nonattainment, but have met the national primary or secondary ambient air quality standards for the pollutant, and have been designated as attainment (*40 CFR § 93.152*).

[6] Unclassifiable areas cannot be classified on the basis of available information as meeting the national primary or secondary air quality standard for a pollutant (*USEPA 2015d*).

Table 8.1.12-1: Ambient Air Quality Standards in Puerto Rico

Pollutant	Averaging Period	NAAQS (Primary Standard)[a]	NAAQS (Secondary Standard)[b]	TAAQS
Carbon monoxide	8-hour	9 ppm (10 mg/m^3)	None	Unknown
	1-hour	35 ppm (40 mg/m^3)	None	
Lead	3-month average	0.15 µg/m^3 (rolling 3-month)	Same as primary	
Nitrogen dioxide	Annual	0.053 ppm (100 µg/m^3)	Same as primary	
Ozone	8-hour	0.075 ppm	Same as primary	
Particulate matter: PM_{10}	24-hour	150 µg/m^3	Same as primary	
Particulate matter: $PM_{2.5}$	Annual	12 µg/m^3	15 µg/m^3	
	24-hour	35 µg/m^3	Same as primary	
Sulfur dioxide	3-hour	None	0.5 ppm (1,300 µg/m^3)	
	1-hour	0.075 ppm (196 µg/m^3)	None	

Source: USEPA 2014a

µg/m^3 = microgram(s) per cubic meter; mg/m^3 = milligram(s) per cubic meter; $PM_{2.5}$ = particulate matter up to 2.5 micrometers in diameter; PM_{10} = particulate matter up to 10 micrometers in diameter; ppm = parts per million
[a] Primary standards are set to protect public health.
[b] Secondary standards are set to protect public welfare, including visibility and crops.

States and territories must establish enforceable plans, known as State Implementation Plans (SIPs), to achieve their AAQS. Regions that are not in compliance with AAQS (i.e., exceed the AAQS limits) are known as nonattainment areas. Those that are in compliance are known as attainment areas. Those without sufficient data are designated unclassifiable and generally have the same obligations as attainment areas. Regions that have previously exceeded the AAQS and subsequently improved air quality to become in compliance are re-designated as maintenance areas. Regions can be classified as in attainment for some criteria pollutants and nonattainment for others. SIPs must describe how the state or territory will maintain compliance in attainment and maintenance areas and will improve air quality in nonattainment areas (*USEPA 2013d*).

In addition to regulating ambient air quality, the CAA also establishes limits on the level of air pollution that can be emitted from both stationary (e.g., manufacturing facility) and non-stationary (e.g., motor vehicle) emission sources. For stationary sources, states and territories may implement more stringent standards than those set by the USEPA. For mobile sources, states or territories must adopt standards set by either USEPA or California (*USEPA 2013d*).

The key permitting programs for major stationary sources are Prevention of Significant Deterioration (PSD) and Nonattainment New Source Review (NANSR). The PSD program ensures that clean air (in attainment, maintenance and unclassifiable areas) is not degraded by new or modified major sources. To obtain a PSD permit, proposed sources must:

- Be designed with best available control technology giving consideration to cost and other factors;
- Show that the added emissions will not cause or contribute to an air pollution increase in excess of the allowable increment, any NAAQS, or any other applicable CAA emissions standard; and

- Show that the added emissions will not have an adverse impact on air-quality related values in a Class I area[7] such as a national park or wilderness area (*USEPA 2013d*).

The NANSR program ensures that proposed major stationary sources will not further degrade air quality in locations where AAQS are not being met (i.e., nonattainment areas). To obtain an NANSR permit, proposed sources must:

- Be designed for the lowest achievable emission rate; and
- Obtain emission offsets (certified reductions in air pollution from existing facilities in the region) to provide a net air quality benefit *(USEPA 2013d)*.

Stationary sources may also be subject to federal air quality regulations under the New Source Performance Standards or National Emission Standards for Hazardous Air Pollutants.

Air pollution from mobile sources is managed primarily through vehicle and fuel standards. Vehicle standards set limits for fuel efficiency and are the basis for state and territory vehicle emissions inspection programs. Fuel standards regulate the amount of sulfur in gasoline and diesel fuels.

Other regulatory programs that may potentially be involved with deployment and operation of the Proposed Action include visibility protection and conformity. Haze[8] is one of the most basic forms of air pollution and it degrades visibility in many U.S. cities and scenic areas (*USEPA 2015c*). National parks and scenic areas are protected from air pollution associated with both new and existing sources of air emissions due to visibility concerns from haze. Protection from new sources of air pollution occurs through the PSD program discussed above. Protection from existing sources occurs through the USEPA's 1999 Regional Haze Rule, which set goals of preventing future and remedying existing impairment in Class I Areas. States and territories are required to adopt progress goals every 10 years, with the ultimate goal of achieving natural background conditions, or conditions which existed before manmade pollution, by 2064 (*USEPA 2010*).

Federal departments and agencies are prohibited from taking actions in nonattainment and maintenance areas without first demonstrating that the actions would conform to the state or territory's SIP. The CAA conformity requirements ensure that federal activities will not: 1) cause or contribute to new air quality violations; 2) worsen existing violations; or 3) delay attainment of AAQS. The transportation conformity requirements apply to projects funded by or requiring approval from the Federal Highway Administration or those related to a project funded under the Federal Transit Act, and thus would not apply to the Proposed Action. The general conformity requirements apply to other federal actions and may apply to the Proposed Action (*USEPA 2013d*).

[7] Class I areas are national parks and wilderness areas in attainment or unclassifiable areas that exceed 5,000 acres in size and were in existence on August 7, 1977.

[8] Haze is caused when sunlight encounters tiny pollution particles in the air. Some light is absorbed by particles; other light is scattered away before it reaches an observer. More pollutants mean more absorption and scattering of light, which reduce the clarity and color of what we see. Some types of particles, such as sulfates, scatter more light, particularly during humid conditions.

8.1.12.3. Ambient Air Quality

One of the key indicators of current ambient air quality in a state or territory is the compliance status of each region compared to the AAQS (refer to Table 8.1.12-1). Compliance is typically evaluated by county, or in some cases, large cities. Based on the limited geographic size of Puerto Rico, the entire territory is evaluated as a single air quality control region (AQCR): Puerto Rico AQCR 244 (*40 CFR § 81, Appendix A*). However, small portions of the territory are designated as nonattainment or maintenance for some of the AAQS. The current nonattainment and maintenance areas within Puerto Rico are listed in Table 8.1.12-2.

Table 8.1.12-2: Nonattainment and Maintenance Areas in Puerto Rico

Pollutant (standard)	Area	Nonattainment Classification	Nonattainment Date	Reclassification Date	2010 Population
Areas in Nonattainment Status					
Lead (2008)	Arecibo	NA	Dec 2011	NA	32,185
Areas in Maintenance Status					
Particulate matter: PM_{10} (1987)	Guaynabo County	Moderate	Nov 1990	Mar 2009	90,470

Sources: USEPA 2015a; USEPA 2015b

NA = not available; PM_{10} = particulate matter up to 10 micrometers in diameter

The Municipality of Arecibo was designated as a lead nonattainment area in December 2011. This area exceeded the 2008 primary and secondary rolling 3-month limit of 0.15μg/m^3. Some of the key contributors of lead emissions in this area are the Battery Recycling Co., Inc. facility and the Puerto Rico Electric Power Authority Cambalache Combustion Turbine Plant. The battery recycling facility is a lead smelter that recycles used motor vehicle batteries and produces about 60 tons of lead per day. The primary actions being taken to address lead issues in Puerto Rico are improved emissions monitoring and control at existing sources as well as review of proposed new or modified sources that may emit lead (*Recycling Today 2011*; *USEPA 2008*).

The Municipality of Guaynabo was designated as a nonattainment area for particulate matter up to 10 micrometers in diameter (PM_{10}) in November 1990 for exceeding the 1987 primary and secondary 24-hour limit of 150 μg/m^3. Some of the key contributors of PM_{10} emissions in this area are grain handling facilities, stone quarries and processing facilities, electric power plants, petroleum refineries, and facilities that use an asphalt blowing process (*Puerto Rico Environmental Quality Board 2008*). As a result of improved control measures, Guaynabo's air quality has improved and in March 2009, the area was re-designated to maintenance status.

As discussed in Section 8.1.12.2, Specific Regulatory Considerations, the two primary permitting programs for proposed new or modified major stationary sources are PSD and NANSR.
In Puerto Rico, the PSD program is implemented by USEPA Region 2. The Puerto Rico Environmental Quality Board implements the NANSR and the minor source construction and operating permit programs (*USEPA 2014b*). The type of permit required in Puerto Rico is primarily based on: 1) the location of the proposed stationary source (attainment vs. nonattainment area); 2) the type of proposed stationary source; and 3) the potential amount of air pollutants that could be emitted per year from the proposed source. Emissions thresholds for

new stationary sources are as follows: PSD review is triggered if facility-wide potential emissions of any criteria pollutant exceed 250 tons per year (tpy); NANSR review is triggered if facility-wide potential emissions of lead exceed 100 tpy. For modified stationary sources, the PSD thresholds vary by pollutant; the NANSR threshold for lead is 0.6 tpy (*40 CFR § 51.166*). Minor source permitting thresholds also vary by pollutant.

As mentioned above, the entirety of Puerto Rico is evaluated as one AQCR. In implementing the federal PSD program, USEPA Region 2 ensures that air quality throughout the territory is not degraded by proposed major sources, specifically ensuring that a proposed major source would not cause ambient air concentrations to increase by more than allowable thresholds listed in Table 8.1.12-3.

Table 8.1.12-3: PSD Allowable Increase Increments

Pollutant	Averaging Period	PSD Increment (μg/m^3)	
		Class I Area[a]	Class II Area[b]
Nitrogen dioxide	Annual	2.5	25
Particulate matter: PM_{10}	Annual	4	17
	24-hour	8	30
Particulate matter: $PM_{2.5}$	Annual	1	4
	24-hour	2	9
Sulfur dioxide	Annual	2	20
	24-hour	5	91
	3-hour	25	512

Source: 40 CFR § 51.166(c)

μg/m^3 = micrograms per cubic meter; $PM_{2.5}$ = particulate matter up to 2.5 micrometers in diameter; PM_{10} = particulate matter up to 10 micrometers in diameter
[a] Class I areas are national parks and wilderness areas in attainment or unclassifiable areas that exceed 5,000 acres in size and were in existence on August 7, 1977.
[b] Class II areas are all other attainment or unclassifiable areas outside Class I areas.

Note that thresholds are lower for Class I Areas, which receive greater protection. However, there are no designated Class I Areas in Puerto Rico; therefore, the entire territory is evaluated according to the Class II Area increments.

As discussed in Section 8.1.12.2, Specific Regulatory Considerations, the USEPA protects visibility in Class I Areas through both the PSD program and the federal 1999 Regional Haze Rule. Since there are no Class I Areas in Puerto Rico and its location limits air emissions from impacting Class I Areas in other states and territories (the closest Class I Area is Virgin Islands National Park), the Regional Haze Rule is not currently applicable in Puerto Rico (*USEPA 2010*; *USEPA 2012b*).

While PSD and visibility programs are critical to air quality in attainment/unclassifiable and Class I Areas, respectively, conformity requirements are a key concern in nonattainment and maintenance areas. As discussed in Section 8.1.12.2, Specific Regulatory Considerations, general conformity (rather than transportation conformity) may apply to the Proposed Action overall.

The emissions thresholds for a general conformity demonstration in Puerto Rico are summarized in Table 8.1.12-4. If annual source emissions are below specified threshold levels, no conformity determination is required. If the emissions exceed the threshold, a conformity determination must be undertaken to demonstrate how the action will conform to the SIP. However, notwithstanding these emission thresholds, certain federal actions are exempt from general conformity requirements. If applicable, the demonstration process includes public notification and response and may require extensive analysis. A map of the nonattainment and maintenance areas in Puerto Rico are shown on Figure 8.1.12-1.

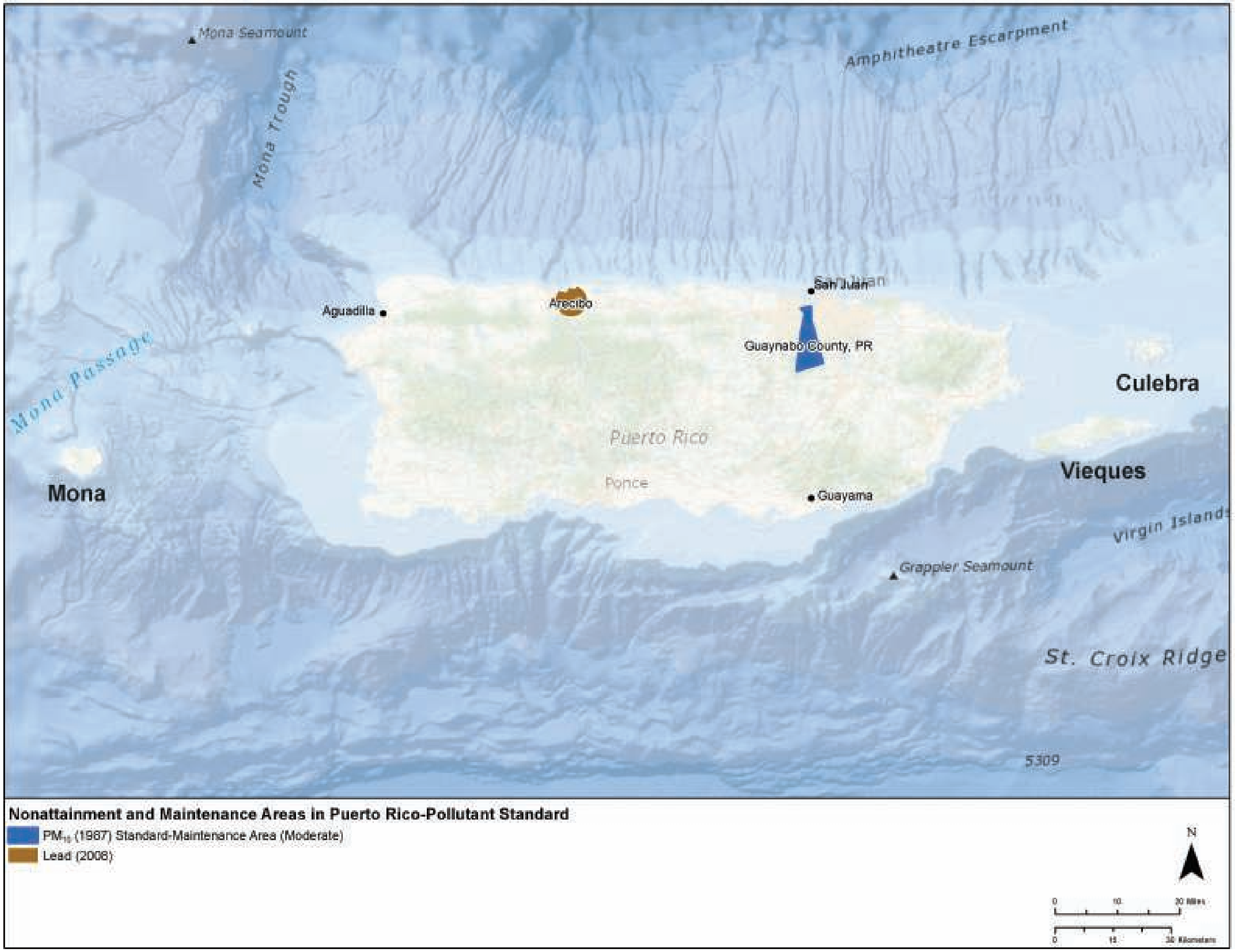
Table 8.1.12-4: General Conformity Emissions Thresholds in Puerto Rico[a]

Pollutant	Region Status	Other Criteria	Emission Threshold (tpy)
Lead	Nonattainment	All nonattainment areas	25
Particulate matter: PM_{10}	Maintenance	All maintenance areas	100

Source: 40 CFR § 93.153

PM_{10} = particulate matter up to 10 micrometers in diameter; tpy = tons per year
[a] Only those pollutant/attainment status combinations that are applicable to Puerto Rico are shown in this table. Other emissions thresholds can be found at *40 CFR § 93.153*.

In most U.S. states and territories, mobile source air pollution is managed primarily through vehicle maintenance and fuel standards. In Puerto Rico, vehicles are required to have a government inspection annually (*Puerto Rico Department of Transportation and Public Works Undated*). USEPA has established fuel standards requiring all diesel-powered vehicles, including highway/on-road vehicles (e.g., trucks, vans) to use 15 parts per million (ppm) ultra-low sulfur diesel (*USEPA 2012a*). All areas of Puerto Rico must comply with this 15 ppm sulfur limit (*Caribbean Petroleum Undated*). Other off-road engines, including those used in certain aircraft, are also regulated by USEPA in order to protect air quality (*USEPA 2013b*). Additionally, the Northeast Diesel Collaborative Puerto Rico committee, formed in 2008, works with USEPA Region 2 and other stakeholders to identify, prioritize, and implement non-regulatory, cost-effective diesel emission reduction strategies in Puerto Rico (*NEDC 2014*).



Sources: USEPA 2011; USEPA 2013a; USEPA 2013c

Figure 8.1.12-1: Nonattainment and Maintenance Areas in Puerto Rico

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8.1.13. Noise and Vibrations

8.1.13.1. Introduction

This section discusses noise and vibration conditions in Puerto Rico. Information is presented regarding noise and vibration characteristics as they relate to humans that would be potentially sensitive to impacts from deployment and operation of the Proposed Action.

Noise is a form of sound caused by pressure variations that the ear can detect and is often defined as unwanted sound (*USEPA 2012*). Noise is one of the most common environmental issues that can interfere with normal human activities and otherwise diminish the quality of the human environment.[1] Typical sources of noise that can result in this type of interference in both urban and suburban surroundings include interstate and local roadway traffic, rail traffic, industrial activities, aircraft, and neighborhood sources like lawn mowers, leaf blowers, etc.

The effects of noise can be classified into three categories:

- Noise events that result in annoyance and nuisance;
- Interference with speech, sleep, and learning; and
- Physiological effects such as hearing loss and anxiety.

Ground-borne vibrations, which in many instances can be caused by tools or equipment that generate noise, can also result from roadway traffic, rail traffic, and industrial activities as well as from some construction-related activities such as blasting, pile-driving, vibratory compaction, demolition, and drilling. Unlike noise, most ground-borne vibrations are not typically experienced every day by most people because the existing environment does not include a significant number of perceptible ground-borne vibration events.

8.1.13.2. Specific Regulatory Considerations

In 1974, the United States Environmental Protection Agency determined that an exterior day-night average sound level (L_{dn}) of 55 A-weighted decibels (dBA) would not adversely affect public health and welfare by interfering with speech or other activities (*USEPA 1974*). Per the Occupational Safety and Health Act of 1970, employees should not be exposed to more than 85 decibels (dB) for an 8-hour day, and if the noise level exceeds the 85 dB threshold, protective measures must be installed to reduce noise exposure (*29 CFR § 1910.95(c)(1)*). See Section 1.8.9, Occupational Safety and Health Act, for more information.

The Regulation of the Environmental Quality Board for the Control of Noise Pollution of Puerto Rico provides numerical noise limits for residential, commercial, and industrial areas (*Puerto Rico Office of the Governor 1981*). These noise level limits are presented in Table 8.1.13-1.

[1] The human environment is the natural and the physical (e.g., structures) environment, and the association of people and their activities to those environments.

Table 8.1.13-1: Noise Level Limits[a]

Emitting Source	Receiving Zones							
	Zone I (Residential)		Zone II (Commercial)		Zone III (Industrial)		Zone IV (Quiet)	
	Daytime	Nighttime	Daytime	Nighttime	Daytime	Nighttime	Daytime	Nighttime
Zone I (Residential)	60	50	65	55	70	60	50	45
Zone II (Commercial)	65	50	70	60	75	65	50	45
Zone III (Industrial)	65	50	70	65	75	75	50	45

Source: Puerto Rico Office of the Governor 1981

[a] The sound levels are based on sound exceeded 10 percent of the measurement period.

The Environmental Quality Board also regulates vibration levels in Puerto Rico. Specifically, the operation of any device that causes vibrations felt or perceived by individuals at an adjacent property boundary is prohibited.

8.1.13.3. Environmental Setting

Noise is generally defined as unwanted sound. Sound can be perceived as pleasant or annoying, and as loudness/intensity, in terms of dB. Sound measurement is refined by using a dBA scale that emphasizes the range between 1,000 and 8,000 cycles per second, which are the sound frequencies most audible to the human ear. The perceived increase in loudness of a sound does not correspond directly to numerical increase in dBA values. Typically, an increase of less than 3 dBA is barely noticeable, an increase of 5 dBA is noticeable, an increase of 10 dBA is perceived as a doubling in apparent loudness, and an increase of 20 dBA is perceived as a four-fold increase in apparent loudness. Table 8.1.13-2 shows typical noise levels generated by common indoor and outdoor activities, and provides possible human effects.

Table 8.1.13-2: Typical Noise Levels and Possible Human Effects

Common Noises	Noise Level (dBA)	Effect
Rocket launching pad (no ear protection)	180	Irreversible hearing loss
Carrier deck jet operation	140	Painfully loud
Air raid siren		
Thunderclap	130	Painfully loud
Jet takeoff (200 feet)	120	Maximum vocal effort
Auto horn (3 feet)		
Pile driver	110	Extremely loud
Loud concert		
Garbage truck	100	Very loud
Firecrackers		
Heavy truck (50 feet)	90	Very annoying
City traffic		Hearing damage (8 hours of exposure)
Alarm clock (2 feet)	80	Annoying
Hair dryer		
Noisy restaurant	70	Telephone use difficult
Freeway traffic		
Business office		

Common Noises	Noise Level (dBA)	Effect
Air conditioning unit	60	Intrusive
Conversational speech		
Light auto traffic (100 feet)	50	Quiet
Living room	40	Quiet
Bedroom		
Quiet office		
Library/soft whisper (15 feet)	30	Very quiet
Broadcasting studio	20	Very quiet
Pin dropping	10	Just audible
Threshold of hearing	0	Hearing begins

Source: WSDOT 2015

dBA = A-weighted decibel
[a] No common 10 dBA source(s) was available, but expected noise effects for this decibel value were included.

In Puerto Rico, just like in any state or territory, noise can be generated from a variety of sources such as industries, railway and roadway vehicle traffic, aircraft, hunting, construction activities, and public gatherings, to name just a few.

In the absence of measured data, typical outdoor sound level by land use category is presented in Table 8.1.13-3. In Puerto Rico, evergreen forest and grassland/herbaceous account for approximately 74 percent of land cover, and developed land covers less than 15 percent of the territory (see Section 8.1.7.3, Land Use and Ownership). Ambient day-night noise levels in major cities such as San Juan, Bayamon, Carolina, and Ponce as well as areas with dense traffic or some commerce or industry are expected to range from 55 to 65 dBA. Ambient day-night noise levels in rural and suburban towns in Puerto Rico (e.g., Jayuya, Adjuntas, Orocovis, etc.) with infrequent traffic are expected to range from 40 to 45 dBA.

Table 8.1.13-3: Typical Outdoor Sound Levels by Land Use Category

Land Use Category	L_d (dBA)[a]	L_n (dBA)[b]	L_{dn} (dBA)[c]
Wilderness areas	35	25	35
Rural and outer suburban areas with negligible traffic	40	30	40
General suburban areas with infrequent traffic	45	35	45
General suburban areas with medium density traffic or suburban areas with some commerce or industry	50	40	50
Urban areas with dense traffic or some commerce or industry	55	45	55
City or commercial areas or residences bordering industrial areas or very dense traffic	60	50	60
Predominantly industrial areas or extremely dense traffic	65	55	65

Sources: Cavanaugh and Tocci 1998; Bies and Hansen 2009

dBA = A-weighted decibel; L_{eq} = equivalent noise level
[a] L_d, or daytime L_{eq}, is the average equivalent sound level for daytime (7 a.m. to 10 p.m.).
[b] L_n, or nighttime L_{eq}, is the average equivalent sound level for nighttime (10 p.m. to 7 a.m.).
[c] L_{dn}, or day-night average sound level, is the average equivalent A-weighted sound level during a 24-hour time period with a 10-dB weighting applied to equivalent sound level during the nighttime hours of 10 p.m. to 7 a.m.

$$L_{dn} = 10log_{10}(\frac{15}{24}10^{L_d/10} + \frac{9}{24}10^{(L_n+10)/10})$$

Territorial recreation lands account for more than 76 percent of recreational lands in Puerto Rico and federal lands, including El Yunque National Forest and National Wildlife Refuges, comprise approximately 24 percent of recreation land in the territory (see Section 8.1.7.5, Recreation). Ambient day-night noise levels in the most sensitive areas in Puerto Rico, such as the El Yunque National Forest, are expected to be 35 dBA or less.

Related to noise, vibration is a fluctuating motion described by displacement with respect to a reference point. Depending on the intensity, vibrations may create perceptible ground shaking and the displacement of nearby objects as well as rumbling sounds. Table 8.1.13-4 lists vibration source levels produced by typical construction machinery and activities at a distance of 25 feet in units of vibration decibels (VdB). The vibration thresholds for human perceptibility and potential building damage are 65 and 100 VdB, respectively *(FTA 2006*).

Table 8.1.13-4: Vibration Source Levels for Select Construction Equipment (VdB)

Equipment[a]	**VdB at 25 feet away**
Pile Driver (impact type)	104-112
Pile Driver (sonic or vibratory type)	93-105
Vibratory Roller	94
Hoe Ram	87
Large Bulldozer	87
Caisson Drilling	87
Loaded Trucks	86
Jackhammer	79
Small Bulldozer	58

Source: FTA 2006

VdB = vibration decibels
[a] The types of equipment listed in this table are included for reference purposes only. It is possible that not all equipment types listed here would be used in the deployment and operation of the Proposed Action.

8.1.14. Climate Change

8.1.14.1. Introduction

This section discusses the setting and context of global climate change effects in Puerto Rico. Information is presented regarding the historical and existing climate parameters including temperature, precipitation, and severe weather.

Climate change, according to the Intergovernmental Panel on Climate Change (IPCC), is defined as

> "a change in the state of the climate that can be identified (e.g., using statistical tests) by changes in the mean and/or the variability of its properties, and that persists for an extended period, typically decades or longer. It refers to any change in climate over time, whether due to natural variability or human activity." (*IPCC 2007*)

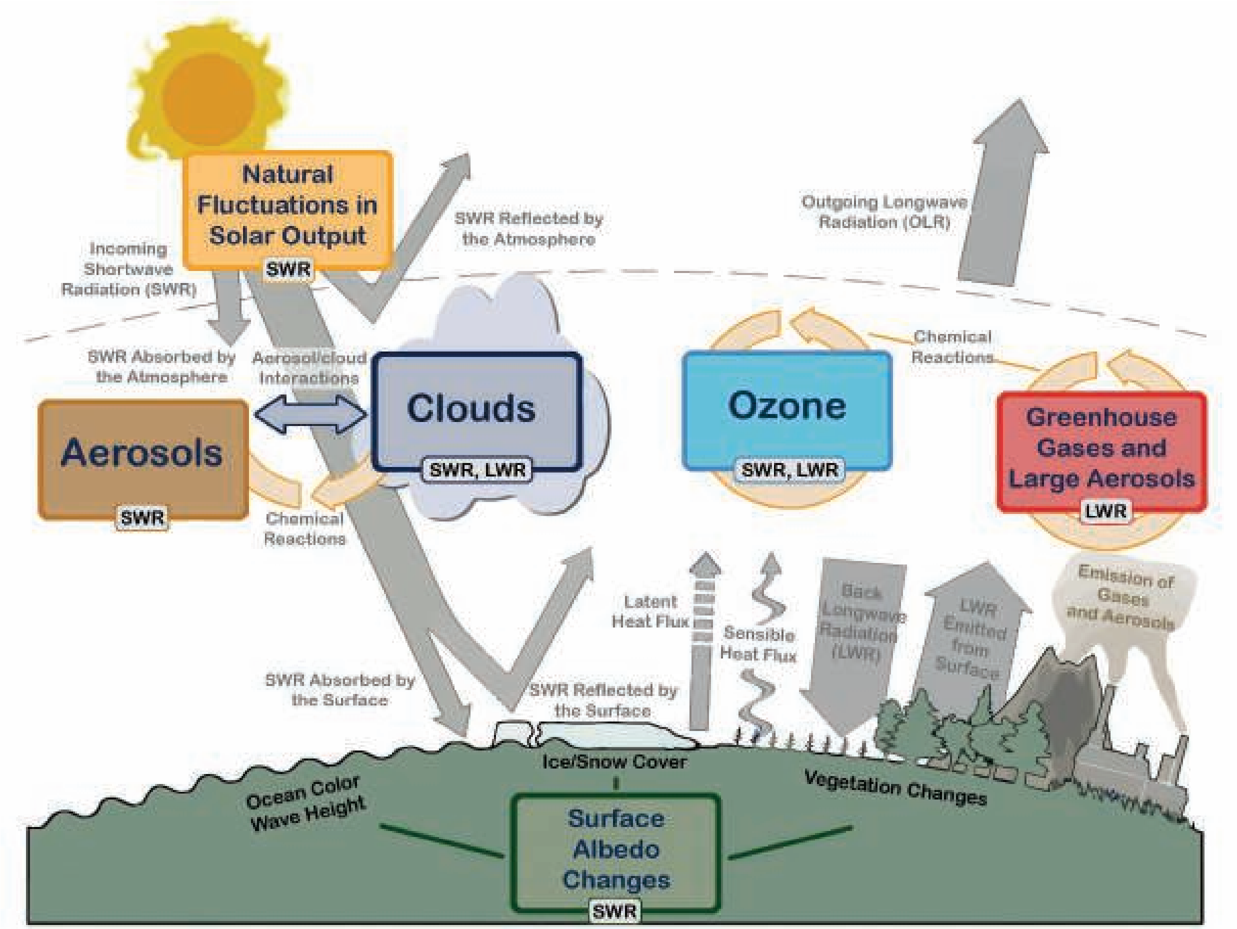
Accelerated rates of climate change are linked to an increase in atmospheric concentrations of greenhouse gas (GHG) caused by emissions from human activities such as burning fossil fuels to generate electricity (*USEPA 2012*). The IPCC is now 95 percent certain that humans are the main cause of current global warming (*IPCC 2013a*). Human activities result in emissions of four main GHGs: carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), and halocarbons (a group of gases containing fluorine, chlorine, or bromine) (*IPCC 2007*). The common unit of measurement for GHGs is metric tons of CO_2-equivalent, which equalizes for the different global warming potential of each type of GHG.

The IPCC reports that "global concentrations of these four GHGs have increased significantly since 1750" and that "atmospheric concentrations of CO_2 increased from 80 parts per million (ppm) of carbon in 1750 to 379 ppm of carbon in 2005." (*IPCC 2007*) The atmospheric concentration of CH_4 and N_2O have increased from pre-industrial values of about 715 and 270 parts per billion to 1774 and 319 parts per billion, respectively, in 2005 (*IPCC 2007*). In addition, the IPCC reports that human activities are causing an increase in various hydrocarbons from near-zero pre-industrial concentrations (*IPCC 2007*).

Both the GHG emissions effects of the Proposed Action, as well as the relationships of climate change effects to the Proposed Action, are considered in this Final Programmatic Environmental Impact Statement (see Section 8.2, Environmental Consequences). Existing climate conditions in the Proposed Action area are described first by state/territory and sub-region, where appropriate, and then by future projected climate scenarios.

8.1.14.2. Context

Output from the sun powers the Earth's climate through solar radiation. The sun's energy in the form of light (including visible light or sunlight), which is electromagnetic radiation, and heat is reflected, transmitted, or absorbed into the Earth's atmosphere. For the Earth's temperature and longer term climate to remain relatively constant, the incoming radiation from the sun must balance with outgoing radiation into space. Most of the outgoing radiation leaving the Earth's surface is longwave radiation, which is also referred to as infrared radiation (*IPCC 2013a*). Some of the infrared radiation that is emitted from the Earth's surface is absorbed by certain gases in the atmosphere, which also emit longwave radiation in all directions. The radiation downward back to the surface adds and traps heat in the earth's surface, creating the greenhouse gas effect. This effect is illustrated in Figure 8.1.14-1 below.



Source: IPCC 2013a

Figure 8.1.14-1: The Greenhouse Gas Effect

Gases including CO_2, CH_4, N_2O, water vapor, and ozone naturally occur in the atmosphere in addition to manufactured pollutants such as hydrofluorocarbons and chlorofluorocarbons. These gases have the ability to emit radiation and can trap outbound radiation within the Earth's atmosphere (*IPCC 2013a*). These gases are collectively called GHGs due to their ability to contribute to the greenhouse gas effect (*IPCC 2013a*). Some GHGs, such as CO_2, CH_4, N_2O, and water vapor, have been continuously released throughout Earth's geologic history through natural processes. Natural carbon sinks[1] that absorb CO_2, such as vegetation and forests, counterbalance this cycle.

Since the industrial revolution, increasing GHG emissions from human activities (referred to as anthropogenic emissions and contrasting with emissions arising from natural processes) have increased the levels of GHGs in the atmosphere. Anthropogenic emissions enhance the greenhouse gas effect and result in a greater amount of heat that is trapped in the atmosphere (*IPCC 2013a*). Human activities that emit GHGs include the combustion of fossil fuel, industrial processes, land use changes, deforestation, and agricultural production.

The Fifth Assessment Report by the IPCC concludes that total radiative forcing, which is the difference between the visible light absorbed by Earth and the energy reflected, is positive. This leads to an increase in energy in the climate system (*IPCC 2013b*). The largest contributor to radiative forcing is caused by the increase of CO_2 in the atmosphere since 1750 (*IPCC 2013b*). Furthermore, according to climate models, continued GHG emission will cause further warming and changes in the climate system (*IPCC 2013b*).

8.1.14.3. Specific Regulatory Considerations

In 2007, the *U.S) Supreme Court in Massachusetts v EPA, 549 U.S. 497 (2007)* ruled that GHGs are air pollutants and can be regulated under the Clean Air Act. Since this ruling, there have been state/territory and federal programs and initiatives that have been proposed and implemented that address GHG emissions in the U.S. The programs that are relevant to the Proposed Action are described below.

Final CEQ Guidance

The Council on Environmental Quality (CEQ) published draft National Environmental Policy Act (NEPA) guidance on the consideration of the effects of climate change and greenhouse gas in February of 2010. Revised draft guidance was published in December 2014 and in August 2016 (after publication of the Draft PEIS) CEQ published its final guidance. This guidance is applicable to all federal agency actions and is meant to facilitate compliance within the legal requirements of NEPA. The CEQ guidance describes how federal agency actions should evaluate GHG and climate change effects in their NEPA reviews, using GHG emissions as a proxy for assessing a proposed action's potential effect on climate change. CEQ defines GHGs to include CO_2, CH_4, N_2O, hydrofluorocarbons, perfluorocarbons, nitrogen triflouride, and sulfur hexafluoride, which is in accordance with section 19 (m) of *Executive Order 13693*. The final

[1] Carbon sinks occur when natural processes absorb more CO_2 than they release. Examples of natural processes that serve as carbon sinks include forests, soils, oceans, and vegetation.

CEQ guidance suggests that agencies consider "(1) the potential effects of a proposed action on climate change as indicated by assessing GHG emissions (e.g. to include, where applicable, carbon sequestration); and (2) the effects of climate change on a proposed action and its environmental impacts." The final guidance recommends that agencies quantify an action's projected direct and indirect GHG emissions when data inputs are reasonably available to support calculations. The final guidance states that "agencies should be guided by the principle that the extent of the analysis should be commensurate with the quantity of the projected GHG emissions and take into account available data and GHG quantification tools that are suitable for and commensurate with the proposed agency action." In addition, CEQ recommends agencies evaluate project emissions and changes in carbon sequestration and storage, when appropriate, in assessing a proposed action's potential climate change impacts. The analysis should assess direct and indirect climate change effects of a proposed project including connected actions, the cumulative impacts of its proposed action, and reasonable alternatives. CEQ advises that climate change effects on the environmental consequences of a proposed action should be described based on available studies, observations, interpretive assessments, predictive modeling, scenarios, and other empirical evidence. The temporal bounds should be limited by the expected lifetime of the proposed project. Mitigation and adaptation measures should be considered in the analysis for effects that occur immediately and in the future.

Territory Regulations and Guidelines

There are no territory regulations or guidelines on GHGs and climate change in Puerto Rico.

8.1.14.4. Historical Climate

Puerto Rico is located in the Greater Antilles in the Caribbean. Historical climate is presented here for the Caribbean including Puerto Rico. A significant warming trend has been observed for temperature since the mid-20th century; this trend is related to El Niño/Southern Oscillation (ENSO) (*Ingram et al. 2013*). ENSO is a naturally occurring phenomenon that involves fluctuating ocean temperatures in the equatorial Pacific, and influences North America (including the Caribbean) as it is a dominant force causing variations in regional climate patterns (*NC State Undated_b*). El Niño conditions suppress the development of tropical storms and hurricanes in the Atlantic Ocean, while La Niña favors hurricane formation (*McPhaden Undated*). ENSO cycles typically only last 6 to 18 months (*NC State Undated_b*). Additionally, changes associated with short term climate variability such as ENSO cycles have been observed to contribute to sea level rise (*Ingram et al. 2013*). There have been no long-term trends observed in annual or seasonal precipitation in the Caribbean over the last century (*Ingram et al. 2013*). There are differing conclusions on the trends related to hurricanes and tropical cyclones over the Atlantic Basin over the last century (*Ingram et al. 2013*). However the accumulated cyclone energy index, which incorporates cyclone intensity and duration, shows hurricane activity across the Atlantic basin has remained high over the past 20 years (*Ingram et al. 2013*).

Climate change projections in the National Climate Assessment (NCA) use a baseline period of 1971 to 2000 for temperature and precipitation. The historical annual average temperature in Puerto Rico during this time period is 80.1 degrees Fahrenheit (°F) and precipitation is 53.3 inches (*NOAA 2015b).*

8.1.14.5. Existing Climate and Meteorology

Puerto Rico has a landmass of 3,424 square miles, and it lies within the area between latitude 17 degrees north and 19 degrees north and longitude 65 degrees west and 68 degrees west (*CIA 2015*). Puerto Rico is located between the Caribbean Sea and the Atlantic Ocean, and is the smallest island within the Greater Antilles.

Puerto Rico's climate is influenced by tropical moist systems and the ENSO (*Jennings et al. 2014*). The tropical moist systems delineate distinct rainy and dry seasons on the island – specifically, June through November (rainy season), and December through May (dry season) (*Jennings et al. 2014*). Puerto Rico's temperature patterns are driven by the ENSO, while precipitation patterns are largely influenced by the location of the North Atlantic Oscillation, which occurs in a roughly 60-year cycle (*Jennings et al. 2014*). The North Atlantic Oscillation consists of two weather pressure systems (a high in the eastern Atlantic Ocean, and a low in Iceland) that move on a seasonal basis, which significantly alters the alignment of the jet stream, especially over the eastern U.S., and ultimately affects temperature and precipitation distributions in this area (*NC State Undated_b*).

Because Puerto Rico has a small landmass, the climate and meteorology information included here applies to the entire island based on data for the territory's capital, San Juan. General meteorological conditions for Puerto Rico, including temperature, precipitation, wind direction, and wind speed were extracted from historic climate information issued by the National Oceanic and Atmospheric Administration; National Environmental Satellite, Data and Information Service; and National Climatic Data Center (NCDC) Comparative Climatic Data for the U.S. through 2012.

Due to Puerto Rico's geographic location, there is minimal seasonal variation in weather throughout the year. The climate of Puerto Rico is tropical maritime, and warm temperatures occur year-round with an average temperature of 81°F with an average humidity of 73 percent. Average rainfall is 56.3 inches per year. Differences in monthly average precipitation vary between a low of 2.6 inches in February to a high of 8.6 inches in October (*Jennings et al. 2014*). Typical wind direction is a northerly direction. Annual average meteorological data for Puerto Rico are shown in Table 8.1.14-1.

Table 8.1.14-1: Annual Average Temperature, Humidity, Precipitation, and Wind Speed Data for Puerto Rico

Parameter	Annual Average
Temperature (°F)	81
Relative Humidity (%)	73
Precipitation: Rain (in)	56.3
Precipitation: snow/sleet (in.)	< 1
Wind speed (mph)	18.6
Max (gust) wind speed (mph)	176.7
Wind direction	N

Source: NOAA 2012

°F = degree Fahrenheit, % = percent, in = inches, mph = miles per hour, N = north

Severe weather data recorded over the last 18 years (1996 to 2014) within Puerto Rico's municipalities include flooding, thunderstorm (marine thunderstorm, thunderstorm wind, lightning, and heavy rain), tornado/funnel cloud, hurricane, and high wind (50-plus miles per hour). Occurrence of such events during that time period is listed in Table 8.1.14-2. Flooding is the most common severe weather phenomenon within the territory.

Table 8.1.14-2: Severe Weather Data for Puerto Rico (1996-2014)

Territory	Number of Recorded Occurrences				
	Flooding[a]	Thunderstorm[b]	Tornado/ Funnel Cloud	Hurricane/ Typhoon	High Wind (50+ mph)
Puerto Rico	1,362	570	41	46	9

Source: NOAA 2015a

mph = miles per hour
[a] Includes NCDC Event Type: Coastal Flood, Flash Flood, and Flood
[b] Includes NCDC Event Type: Marine Thunderstorm Wind, Thunderstorm Wind, Lightning, and Heavy Rain

8.1.15. Human Health and Safety

8.1.15.1. Introduction

This section provides a health profile of the population of Puerto Rico where potential worker and community health and safety effects related to the deployment and operation of the Proposed Action could occur. The health profile includes a summary of basic population health indicators and a discussion of any key community health and safety issues, with a focus on those health issues that may be potentially sensitive to impacts from the Proposed Action. A discussion of health and safety issues related to radio frequency exposure is provided in Section 2.4, Radio Frequency Emissions.

This health profile is based on a review of various data sources, including the Centers for Disease Control and Prevention, the Puerto Rico Department of Health, the World Health Organization, and the United States (U.S.) Environmental Protection Agency (USEPA).

The existing environment for health and safety is defined by occupational and environmental hazards likely to be encountered during the deployment, operation, and maintenance of towers, antennas, cables, utilities, and other equipment and infrastructure at existing and potential FirstNet telecommunication sites. There are two human populations of interest within the existing environment of health and safety, 1) telecommunication occupational workers and 2) the general public near telecommunication sites. Each of these populations could experience different degrees of exposure to hazards as a result of their relative access to FirstNet telecommunication sites and their function throughout the deployment and operation of the Proposed Action.

The health and safety topics reviewed in this section include regulatory considerations for occupational safety for telecommunications workers as well as infectious diseases, chronic diseases affected by air pollution, occupational injuries and fatalities, and hazardous/contaminated sites.

8.1.15.2. Specific Regulatory Considerations

For worker health and safety, the Puerto Rico Occupational Safety and Health Administration (PR OSHA) have adopted all the U.S. Occupational Safety and Health Act of 1970 standards and regulations that cover both private and public sector workers (see Section 1.8.9, Occupational Safety and Health Act, for more information). This Act sets and enforces protective standards to assure safe and healthful working conditions for all workers. PR OSHA maintains authority over all private sector workplaces, as well as maritime employers such as shipyards, marine terminals, and longshoring, and military facilities.

PR OSHA, in conjunction with the U.S. OSHA, is the primary regulatory agency in charge of the enforcement of worker safety and health regulations; however, other regulations may play a role in activities, including handling of hazardous waste.

The following four laws are overseen by the USEPA and regulate aspects of worker health in conjunction with U.S. OSHA:

- The main objective of the Resource Conservation and Recovery Act of 1976 is to "protect human health and the environment from the potential hazards of waste disposal, to conserve energy and natural resources, to reduce the amount of waste generated, and to ensure that wastes are managed in an environmentally sound manner" (*USEPA 2013a*);
- The Comprehensive Environmental Response, Compensation, and Liability Act or Superfund law was designed to help clean up hazardous waste sites and releases of pollutants or contaminants that may negatively affect public health (*USEPA 2015b)*;
- The Toxic Substances Control Act regulates the introduction of new or existing chemicals that present a risk to human health or the environment (*USEPA 2015c*); and
- The Emergency Planning and Community Right-to-Know Act of 1986 was designed to assist communities in planning for emergencies related to hazardous waste. The law also requires industry to inform federal, state/territory, and local governments on the storage use and releases of hazardous chemicals (*USEPA 2015a*).

Other regulatory considerations that are applicable to worker and community health and safety are outlined in Section 8.1.1., Infrastructure; Section 8.1.4, Water Resources; Section 8.1.10, Environmental Justice; Section 8.1.12, Air Quality; and Section 8.1.13, Noise and Vibrations.

8.1.15.3. Health Overview

Several measures of general health status, such as life expectancy (how long an individual from a certain population is expected to live), mortality rates, and disease prevalence are common indicators of the overall health status of a population. Table 8.1.15-1 summarizes some of the key health indicators for Puerto Rico compared to the averages for the U.S.

Table 8.1.15-1: Key Health Indicators for Puerto Rico

Health Outcome Indicator (data year)	Puerto Rico	United States
Age-adjusted death rate per 100,000 population (2013)	667.8	731.9
Life expectancy at birth (2010)	Male: 74.4 years Female: 82.1 years	Male: 76.2 years Female: 81.0 years
Leading causes of death, % of total deaths (2013)	17.9% - cancer 17.4% - heart disease 10.8% - diabetes 6.4% - Alzheimer's 4.6% - cerebrovascular disease	23.5% - heart disease 22.5% - cancer 5.7% - chronic lower respiratory diseases 5.0% - accidents 5.0% - cerebrovascular
Infant mortality rate, per 1,000 live births (2013)	7.15	5.96

Sources: CDC 2010; CDC 2013b; PAHO/WHO 2010; KFF 2010

Compared to the overall U.S., Puerto Rico has a lower all-cause death rate, but a higher rate of infant mortality. While heart disease and cancer account for the leading causes of death in Puerto Rico (as with the overall U.S.), they have among the lowest rates of all states and territories. However, deaths caused by diabetes, influenza, and pneumonia are among the highest (*OWH 2010)*. Approximately half of all adults in Puerto Rico are suffering from at least one chronic disease according to the Pan American Health Organization/World Health Organization. Heart disease, cancer, diabetes, and asthma are the leading causes of death and disability (*PAHO/WHO 2014*).

8.1.15.4. Summary of Key Health and Safety Conditions for Puerto Rico

The following summarizes key health and safety conditions in Puerto Rico, with a focus on those conditions that could potentially be impacted by the activities and infrastructure associated with the Proposed Action, or potentially increase health risk to the Proposed Action workforce.

Infectious diseases—The mosquito borne diseases of most concern in Puerto Rico are dengue (most common) and chikungunya (an emerging threat). The viruses are transmitted to humans through infected mosquito bites. Both diseases are now endemic to the area. In 2010, Puerto Rico experienced its largest outbreak of dengue infections with 26,766 reported cases. Epidemics also occurred in the country in 1998 and 2007 (*Departamento de Salud 2012; CDC 2015*). Through the first half of 2015, 739 probable and 29 confirmed cases of dengue were reported in the country. While there is no prophylaxis or cure for dengue, the mortality rate for the disease can be lowered to less than 1 percent if severe cases are detected early and symptoms (hemorrhaging, organ damage, and dehydration) are treated. Dengue continues to be endemic in Puerto Rico, and efforts by the Pan American Health Organization and the local Centers for Disease Control and Prevention branch have been underway to provide management, prevention, and surveillance (*PAHO/WHO 2014; CDC 2015*). Chikungunya appeared in the Caribbean in late 2013; while it is rarely fatal (mostly in older adults), it can cause high fever, severe joint and muscle pain, and headaches (*CDC 2015*). In some patients, joint pain can last for months or even years after becoming infected. By March 2015, there were more than 1,300,000 cases of chikungunya reported in the Americas (*PAHO/WHO 2015*). Through the first half of 2015, 415 suspected cases and 79 confirmed cases have been reported in Puerto Rico (*PAHO/WHO 2015*).

Chronic diseases affected by air pollution—Common mobile source air emissions associated with health concerns include nitrogen dioxide and particulate matter up to 2.5 micrometers in diameter ($PM_{2.5}$). Fossil fuel combustion associated with traffic and the use of heavy machinery and generators is the primary source of $PM_{2.5}$ and nitrogen oxides that could be generated by the Proposed Action. Baseline levels of air pollutants in Puerto Rico are addressed in Section 8.1.12, Air Quality. The focus of this section is on vulnerable groups that may be particularly sensitive to even short-term increases in $PM_{2.5}$ or nitrogen oxides.

Research to date has not revealed the existence of "No Observed Adverse Effects Level" thresholds for $PM_{2.5}$ or nitrogen oxides below which no health effects would be expected for sensitive populations (*HEI 2010; USEPA 2009, 2013a; Kelly and Fussell 2011; Levy et al. 2002; Nishimura et al. 2013; Patel and Miller 2009; O'Neill et al. 2005, 2007; Sarnat and Holguin 2007*). Sensitive populations for exposure to $PM_{2.5}$ and nitrogen dioxide are:

- Those with chronic respiratory diseases (asthma and chronic obstructive pulmonary disease), particularly children and the elderly;
- Those with acute respiratory infections, particularly children and the elderly;
- Those with chronic heart diseases; and
- Diabetics.

Table 8.1.15-2 below summarizes health conditions in Puerto Rico and the U.S. that can be exacerbated by air pollution (respiratory illnesses and diabetes). Compared to the U.S., Puerto Rico shows poorer health status for prevalence of asthma and diabetes. However, the data also show lower percentages of deaths from chronic lower respiratory disease and heart disease in Puerto Rico relative to the U.S. as a whole, and a comparable rate of influenza and pneumonia deaths compared to the U.S.

Table 8.1.15-2: Health Conditions Affected by Air Pollution

Health Condition (data year)	Puerto Rico	United States
Adult asthma prevalence[a] (2013)	10.3%	9.0%
Chronic lower respiratory diseases, percentage of all deaths (2013)	3.4%	5.6%
Influenza and pneumonia, percentage of all deaths (2013)	2.6%	2.2%
Heart disease, percentage of all deaths (2013)	17.4%	23.5%
Diabetes prevalence (2013)[b]	14.9%	9.8%

Sources: CDC 2013a; CDC 2013b

[a] Defined as having been told by a doctor that you currently have asthma.
[b] Defined as ever having been told by a doctor that you have diabetes

Smoking is the primary behavioral health risk factor for illnesses that are affected by air pollution. In 2013, Puerto Rico had a lower percentage of current smokers (an estimated 10.8 percent) than the U.S. (19 percent) (*CDC 2013a*).

Occupational injuries and fatalities—In 2015, the incidence rate of nonfatal occupational injuries and illnesses in Puerto Rico for all industries was 3.7 compared to 3.3 in the U.S. (*BLS 2015*).[1] The total fatal occupational injuries in 2014 (the most recent year for which data were available) amounted to 29 cases in Puerto Rico; 4,821 total fatal occupational injuries occurred in the U.S. in the same year (*BLS 2014 and BLS 2016*).

[1] Incidence rates are based on the number of injuries and illnesses per 100 full-time workers and were calculated as the number of injuries and illnesses divided by the total hours worked by all employees during the calendar year, divided by a base of 200,000 (or 100 full-time workers working 40 hours per week for 50 weeks of the year).

Hazardous waste/contaminated areas—Existing environmental contaminants in soil or water at a deployment site could potentially result in a worker or community health concern if such contaminants were not managed during deployment and operations. Health effects from environmental contaminants can range from experiences of physical irritation/nuisance to acute illness and chronic disease outcomes. Existing areas of contamination can come from both existing industrial facilities as well as legacy contaminated sites.

Puerto Rico is a relatively heavily industrialized area. According to the USEPA's Toxic Release Inventory (TRI), as of 2013 Puerto Rico ranks 27 out of 56 states/territories nationwide in toxic releases[2] and has 113 TRI facilities with a total of approximately 3,600,000 pounds of disposal or other releases (*USEPA 2013b)*. The TRI database is a measure of the industrial nature of an area and the overall chemical use, and can be used to track trends in releases over time. The "releases" do not necessarily equate to chemical exposure by humans, or necessarily constitute quantifiable health risks because the releases include all wastes generated by a facility – the majority of which are disposed via managed, regulated processes that minimize human exposure and related health risks (e.g., in properly permitted landfills or through recycling facilities).

The electric utilities industry is the largest contributor of on-site releases in Puerto Rico. The Puerto Rico Electric Power Authority - Aguirre Power Generation Complex is the highest contributor of total on- and off-site releases with a primary chemical release of sulfuric acid, representing about a third of total air releases (*USEPA 2013b*). Additionally, according to the USEPA (*2015c*), Puerto Rico has 16 listed active Superfund sites (legacy contamination).

Affected environment discussions for radio frequency, transportation, noise/vibration, and public safety services, all of which have the potential to influence community and worker health, are covered in Section 2.4, Radio Frequency Emissions; Section 8.1.1.3, Transportation; Section 8.1.13, Noise and Vibrations; and Section 8.1.1.4, Public Safety Services, respectively, in this Final Programmatic Environmental Impact Statement.

[2] Rank 1 represents the highest volume of releases.

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8.2. ENVIRONMENTAL CONSEQUENCES

This section describes the potential direct and indirect environmental impacts at the programmatic level that could be caused by the deployment, operation, and maintenance of the Proposed Action. Mitigation measures, as defined through permitting and/or consultation with the appropriate resource agencies, would be required to be implemented as part of deployment and operation of the Proposed Action to avoid or reduce potential impacts to resources. Implementation of best management practices (BMPs), as practicable or feasible, could further reduce the potential for impacts. Both mitigation measures and BMPs are discussed in Chapter 11, BMPs and Mitigation Measures. Cumulative environmental impacts of the Proposed Action and other past, present, and reasonably foreseeable projects are described separately in Chapter 10, Cumulative Effects. In each of the resource area-specific sections that follow, a table is presented outlining each of the potential types of effects that could impact the given resource at the programmatic level.

The levels of impacts for each resource area are defined as follows:

- *Potentially significant,* where there is substantial evidence that an effect may be significant at the programmatic level;
- *Less than significant with BMPs and mitigation measures incorporated,* where the use of mitigation measures reduce an effect from a *potentially significant* impact to a *less than significant* impact at the programmatic level;
- *Less than significant,* where the activity creates impacts but no significant impacts at the programmatic level; or
- *No impact,* which applies where a project does not create an impact at the programmatic level.

Characteristics of each type of effect, including magnitude or intensity, geographic extent, and duration or frequency, were used to determine the impact significance rating associated with each potential impact at the programmatic level for each type of project activity associated with the Proposed Action. Given the nature of this programmatic evaluation, and because the Proposed Action could potentially cover a wide variety of actions that would take place in various landscapes, the potential impacts to the resources are presented as a range of possible impacts.

It is possible that, for some effect types, impact ratings could be *less than significant* at the programmatic level yet *potentially significant* at the site-specific level (although with BMPs and mitigation measures this is expected to be rare). For example, while potential impacts from a specific FirstNet project taking place in a single wetland may not rise to the level of significance at the programmatic level (based on the programmatic impact significance criteria), such impacts could be considered potentially significant at the site-specific level when applying site-specific significance criteria. As another example, if it is determined that the environmentally preferred location for a new wireless communication tower requires an access road that could impact a historic property, the impact to the particular property could be significant locally, but not at the programmatic level based on the established criteria. In these scenarios, site-specific BMPs may be needed in addition to those outlined in the Final Programmatic Environmental Impact Statement. Any additional BMPs would be determined as part of the site-specific environmental review, as required, and likely in coordination with the appropriate resource agencies.

8.2.1. Infrastructure

8.2.1.1. Introduction

This section describes potential impacts to infrastructure in Puerto Rico including transportation, communications and other utilities associated with deployment and operation of the Proposed Action. Mitigation measures, as defined through permitting and/or consultation with the appropriate resource agency, would be implemented as part of deployment and operation of the Proposed Action to help avoid or reduce potential impacts to infrastructure. Implementation of best management practices (BMPs), as practicable or feasible, could further reduce the potential for impacts. Both mitigation measures and BMPs are discussed in Chapter 11, BMPs and Mitigation Measures.

8.2.1.2. Impact Assessment Methodology and Significance Criteria

The potential impacts of the Proposed Action on infrastructure, which includes public safety telecommunications systems, transportation safety and capacity, utility services, access to emergency services and commercial communications systems, were evaluated using the significance criteria presented in Table 8.2.1-1. As described in Section 8.2, Environmental Consequences, the categories of impacts are defined at the programmatic level as *potentially significant*, *less than significant with BMPs and mitigation measures incorporated*, *less than significant*, or *no impact*. Characteristics of each impact type, including magnitude or intensity, geographic extent, and duration or frequency, were used to determine the impact significance rating associated with each potential impact.

Given the nature of this programmatic evaluation, and because the Proposed Action could potentially cover a wide variety of actions that would take place in various landscapes, the potential impacts to infrastructure addressed in this section are presented as a range of possible impacts.

Table 8.2.1-1: Impact Significance Rating Criteria for Infrastructure

Type of Effect	Effect Characteristics	Impact Level			
		Potentially Significant	**Less than Significant with BMPs and Mitigation Measures Incorporated**	**Less than Significant**	**No Impact**
Transportation system capacity and safety	Magnitude or Intensity	Creation of substantial traffic congestion/delay and/or a substantial increase in transportation incidents (e.g., crashes, derailments)	Effect that is *potentially significant*, but with BMPs and mitigation measures is *less than significant* at the programmatic level	Minimal change in traffic congestion/delay and/or transportation incidents (e.g., crashes, derailments)	No effect on traffic congestion or delay, or transportation incidents
	Geographic Extent	Regional impacts observed throughout the state or territory		Effects realized at one or multiple isolated locations	NA
	Duration or Frequency	Permanent: persisting indefinitely		Short-term effects would be noticeable for up to the entire construction phase or a portion of the operation phase	NA
Strain on capacity of local health, public safety, and emergency response services	Magnitude or Intensity	Impacted individuals or communities cannot access health care and/or emergency health services or access is delayed due to the Proposed Action activities	Effect that is *potentially significant*, but with BMPs and mitigation measures is *less than significant* at the programmatic level	Minor delays to access to care and emergency services that do not impact health outcomes	No impacts on access to care or emergency services
	Geographic Extent	Regional impacts observed ("regional" assumed to be at least a municipio or municipio-equivalent geographical extent, could extend to state/territory)		Impacts only at a local/neighborhood level	NA
	Duration or Frequency	Duration is constant during the construction and deployment phase		Rare event during construction and deployment phase	NA

Type of Effect	Effect Characteristics	Impact Level			
		Potentially Significant	**Less than Significant with BMPs and Mitigation Measures Incorporated**	**Less than Significant**	**No Impact**
Modifies existing public safety response telecommunication practices, physical infrastructure, or level of service in a manner that directly affects public safety communication capabilities and response times	Magnitude or Intensity	Substantial adverse changes in public safety response times and the ability to communicate effectively with and between public safety entities	Effect that is *potentially significant*, but with BMPs and mitigation measures is *less than significant* at the programmatic level	Minimal change in the ability to communicate with and between public safety entities	No perceptible change in existing response times or the ability to communicate with and between public safety entities
	Geographic Extent	Local/city, municipio/region, or state/territory		Local/city, municipio/ region, or state/territory	Local/city, municipio/region, or state/territory
	Duration or Frequency	Permanent or perpetual change in emergency response times and level of service		Change in communication and/or the level of service is perceptible but reasonable to maintaining effectiveness and quality of service	NA
Effects to commercial telecommunication systems, communications, or level of service	Magnitude or Intensity	Substantial adverse changes in level of service and communications capabilities	Effect that is *potentially significant*, but with BMPs and mitigation measures is *less than significant* at the programmatic level	Minor changes in level of service and communications while transitioning to the new system	No perceptible effect to level of service or communications while transitioning to the new system
	Geographic Extent	Local/city, municipio/region, or state/territory		Local/city, municipio/region, or state/territory	Local/city, municipio/region, or state/territory
	Duration or Frequency	Persistent, long-term, or permanent effects to communications and level of service		Minimal effects to level of service or communications lasting no more than a short period (minutes to hours) during the construction and deployment phase	NA

Type of Effect	Effect Characteristics	Impact Level			
		Potentially Significant	**Less than Significant with BMPs and Mitigation Measures Incorporated**	**Less than Significant**	**No Impact**
Effects to utilities, including electric power transmission facilities and water and sewer facilities	Magnitude or Intensity	Substantial disruptions in the delivery of electric power or to physical infrastructure that results in disruptions, including frequent power outages or drops in voltage in the electrical power supply system (“brownouts”); disruption in water delivery or sewer capacity, or damage to or interference with physical plant facilities that impact delivery of water or sewer systems	Effect that is *potentially significant*, but with BMPs and mitigation measures is *less than significant* at the programmatic level	Minor disruptions to the delivery of electric power, water, and sewer services or minor modifications to physical infrastructure that result in minor disruptions to delivery of power, water, and sewer services	There would be no perceptible impacts to delivery of other utilities and no service disruptions
	Geographic Extent	Local/city, municipio/region, or state/territory		Local/city, municipio/region, or state/territory	Local/city, municipio/region, or state/territory
	Duration or Frequency	Effects to other utilities would be seen throughout the entire construction phase		Effects to other utilities would be of short duration (minutes to hours) and would occur sporadically during the entire construction phase	NA

NA = not applicable

8.2.1.3. Description of Environmental Concerns

Transportation System Capacity and Safety

Deployment and operation of the Proposed Action could potentially impact transportation system safety and capacity in Puerto Rico. The transport of heavy equipment required to support any clearance, drilling, and construction activities needed for network deployment could potentially have an impact on traffic congestion and transportation safety. Deployment activities including plowing, directional boring, and trenching necessary for the installation of fiber optic cable along the road and within the public road right-of-way (ROW) also have the potential to create temporary traffic congestion. The presence of deployable technologies such as Cell on Wheels, Cell on Light Truck, System on Wheels, and Deployable Aerial Communications Architecture could potentially impact air and land-based traffic congestion and safety. However, potential impacts would likely be minimal when deployable technologies are stationed in the more rural areas of Puerto Rico where there is less transportation system infrastructure that could be disrupted.

Submarine deployment activities have the potential to increase boat traffic and congestion on a short-term basis. Submarine deployment activities likely to create potential impacts include the installation of sealed cables in limited nearshore waters and inland waterbodies and the construction of landings and facilities onshore to accept cables.

Each of the potential impacts to transportation capacity and safety discussed above would likely be short term, would be regionally based around the ongoing phase of construction, and would likely return to normal conditions after a few months or less.

Strain on Capacity of Local Health, Public Safety, and Emergency Response Services

Deployment activities involving plowing, directional boring, or trenching along the road during the installation of fiber optic cable, or construction of wireless towers, or other structures could have the potential to temporarily create minor road blockages or cause radio interference during the transition to the new system. Deployable technologies with cellular base stations that could require connection to utility power cables could have the potential to create temporary power outages or utility service interruptions. While the potential impacts are not certain, these potential impacts would be localized, short-term, and temporary, and the Proposed Action would likely improve overall access to health care and emergency health services during the operations phase. Deployable Technologies in particular would help to provide coverage in areas of Puerto Rico where fixed infrastructure cannot be erected due to a variety of factors. Puerto Rico has a complex geography and a fragmented landscape and is prone to natural catastrophes like hurricanes and earthquakes. With successful completion of the Proposed Action, FirstNet would have established a nationwide broadband network allowing public safety officers and emergency responders to communicate with each other across agencies and jurisdictions, thus improving current conditions for first responders and impacted individuals in emergency situations.

Public Safety Communication Capabilities and Response Times

Within the territory, public safety communications are supported primarily by the Puerto Rico Interoperable Communications Committee and the Puerto Rico Public Safety Broadband Network Committee. FirstNet provides the funding necessary for the Public Safety Broadband Network Committee, Homeland Security Regional Boards, and the Interoperable Communications Committee to educate local jurisdictions about updates to the statewide interoperability plan (*NTIA 2013*). Puerto Rico lacks a real-time notification system to alert identified health care providers of a disaster event. Puerto Rico also lacks patient and victim tracking systems, a medical communication system with one layer of redundancy,[1] and a real-time syndromic surveillance system. The Proposed Action is needed to address existing deficiencies in public safety communications interoperability, durability, and resiliency that have been highlighted in recent years for the ways in which they have hindered response activities in high profile natural and man-made disasters.

As stated in Chapter 2, Description of the Proposed Action and Alternatives, FirstNet proposes to implement a nationwide public safety broadband network (NPSBN) that would involve high-speed fourth generation Long Term Evolution technology (as defined by Section 2.1.1, Characteristics of the NPSBN), a core network, and a radio access network. A wide range of new telecommunications infrastructure and deployable technologies would likely be implemented as a part of the core network, including fiber optic cable, towers, data centers, microwave technology, and others. The radio access network is necessary for the connection of user devices and includes infrastructure related to the radio base station, such as communication towers, cell site equipment, antennas, deployable mobile hotspots, and backhaul equipment required to enable wireless communications with devices using the public safety broadband spectrum.

The NPSBN intends to provide a backbone to allow for improved communications by carrying high-speed data, location information, images, and, eventually, streaming video. This capability could increase situational awareness during an emergency, thereby improving the ability of the public safety community to effectively engage and respond. The NPSBN is also intended to have a higher level of redundancy and resiliency than current commercial networks to support the public safety community effectively. The backhaul, or intermediate links that carry user traffic, including voice, data and video, and signaling from radio base stations to the core network, would likely be accomplished through fiber optic and microwave technology, with an emphasis on redundancy that is intended to allow the network to continue to function in events of extreme demand. The NPSBN would also include, by statute, a variety of characteristics, one of which being substantial rural coverage. Puerto Rico has a complex geography, and many communities within the territory are facing high levels of poverty. The rural nature of the island leads to a lack of reliable public safety communication capabilities (*CNMI DOC 2013*). Implementation of the FirstNet public safety telecommunications infrastructure is intended to significantly improve public safety communications capabilities and response times in both urban and rural areas of Puerto Rico during operations.

[1] Redundancy refers to the duplication of equipment or processes to help maintain continuity of operations.

Effects to Commercial Telecommunication Systems, Communications, or Level of Service

The capacity of local health, public safety, and emergency response services would likely experience negligible adverse impacts during deployment or operation phases. During deployment and system optimization, existing services would likely remain operational in a redundant manner ensuring continued operations and availability of services to the public. The only potential adverse impact would be extremely rare – and that is if emergency response services were using transportation infrastructure to respond to an emergency at the exact time that deployment activities were taking place. This type of impact would be isolated at the local or neighborhood level, and the likelihood of such an impact would be extremely low. Once operational, the new network is envisioned to provide substantial beneficial impacts to the capacity of local health, public safety, and emergency response services through enhanced communications infrastructure, thereby increasing capacity for and enhancing the ability of first responders, local health officials, and public safety officials to communicate during emergency response situations. Based on the impact significance criteria presented in Table 8.2.1-1, potential adverse impacts would be *less than significant* at the programmatic level.

Effects to Utilities

Potential impacts to utilities, including electric power transmission facilities, could occur throughout the deployment/construction phase but would return to their original state during the operational phase. During deployment activities, to the extent practicable or feasible, FirstNet and/or their partners would work to implement wired projects using existing public road ROWs. These ROWs often include existing utility corridors and other easements. As part of the Proposed Action, FirstNet could also install new fiber on existing poles in an effort to improve disaster resistance and resiliency. Pole replacement could be necessary as a part of project activities. Deployable technologies could be connected to power utility cables, which could potentially result in temporary power outages. It is unlikely that these project activities would increase the load on the existing electrical utilities; however, the implementation of BMPs and mitigation measures (as discussed in Chapter 11, BMPs and Mitigation Measures), such as organizing scheduled coordination with other service providers while working within utility corridors and easements, could help avoid or minimize the potential for overloading or interrupting the service. Also noteworthy is that Puerto Rico Electric Power Authority, the sole power company in Puerto Rico, has had a long history of frequent power outages or drops in voltage in their electrical power supply system (*Caribbean Business 2014*). Once deployment activities have terminated, if there was any change in service or added burden to the system, electrical utilities would likely return to their original state.

Deployment of new submarine cable would involve the installation of specially sealed cables in nearshore waters and inland waterbodies. However, it is not likely that these project activities would impact offshore utilities. Therefore, based on the impact significance criteria presented in Table 8.2.1-1, potential adverse impacts would be *less than significant* at the programmatic level.

8.2.1.4. Potential Impacts of the Preferred Alternative

The following section assesses potential impacts associated with implementation of the Preferred Alternative, including deployment and operation activities.

Potential Deployment Impacts

As described in Section 2.1.2, Proposed Action Infrastructure, implementation of the Preferred Alternative could result in the deployment of various types of facilities or infrastructure. Depending on the physical nature and location of the facility/infrastructure and the specific deployment requirements, some activities would result in potential impacts to public safety telecommunications systems, commercial communications, transportation capacity and safety, and utilities, and others would not. In addition, and as explained in this section, various types of Preferred Alternative infrastructure could result in a range of *no impacts* to *less than significant* impacts at the programmatic level depending on the deployment scenario or site-specific conditions. Site-specific analysis may be required depending on the site conditions, the type of deployment, or any other permits or permissions necessary to perform the work.

Activities Likely to Have No Impacts

Of the types of facilities or infrastructure development scenarios described in Section 2.1.2, Proposed Action Infrastructure, the following are likely to have *no impacts* at the programmatic level to public safety telecommunications infrastructure, commercial communications, transportation capacity and safety, access to emergency services, and utilities under the conditions described below:

- Wired Projects
  - Use of Existing Conduit–New Buried Fiber Optic Plant: Disturbance associated with the installation of fiber optic cable in existing conduit would be limited to entry and exit points of the existing conduit in previously disturbed areas. It is anticipated that there would be *no impacts* to infrastructure resources at the programmatic level since the activities that would be conducted at these small entry and exit points are not likely to produce perceptible changes or disruption of transportation, telecommunications, or utility services.
  - Use of Existing Buried or Aerial Fiber Optic Plant or Existing Submarine Cable: Lighting up of dark fiber would have *no impacts* to infrastructure resources as this activity is not likely to produce perceptible changes or disruption of transportation, telecommunications, or utility services.
- Satellites and Other Technologies
  - Deployment of Satellites: FirstNet does not anticipate launching satellites as part of the deployment of the NPSBN; however, it could include equipment on satellites that are already being launched for other purposes. As adding equipment to an existing launch vehicle would be very unlikely to impact infrastructure resources, it is anticipated that this activity would have *no impact* to those resources.

Activities with the Potential to Have Impacts

Potential deployment-related impacts to telecommunications infrastructure as a result of implementation of the Preferred Alternative would encompass a range of potential impacts that could occur as a result of excavation, trenching, construction, or maintenance within public road ROWs and utility corridors, collocation of network equipment on existing structures, transport or positioning of deployable technologies, construction of access roads, and installation of new fiber optic cables, poles, towers or ancillary structures. Potential impacts that could possibly result due to the deployment activities of the Preferred Alternative could include increased traffic congestion, current telecommunication system interruption, increased emergency response times, and utility interruptions. The types of infrastructure development scenarios or deployment activities that could be part of the Preferred Alternative and result in potential impacts to telecommunications infrastructure, commercial communications systems, transportation capacity and safety, utilities, and access to emergency facilities include the following:

- Wired Projects
  - New Build–Buried Fiber Optic Plant: Deployment activities involving plowing (including vibratory plowing), trenching, or directional boring and the construction of points of presence,[2] huts, or other associated facilities or hand-holes along the utility corridor or within the public road ROW could potentially result in minor, temporary disruptions to some utility services. Construction along a utility corridor could require that certain utilities are shut down during construction. Temporary traffic congestion and limited access to emergency services could occur as a result of construction and the presence of heavy machinery and vehicles near public road ROWs. Public safety and commercial telecommunications systems could also be temporarily disturbed during construction due to potential short-term radio interference; however during operation the buried fiber optic plant is anticipated to improve coverage and telecommunications capabilities, as discussed below.
  - New Build–Aerial Fiber Optic Plant: Construction of new fiber optic cable involving installation of new poles and hanging cables on disturbed and undisturbed ROWs or easements could potentially impact some utility services. The presence of heavy equipment and vehicles during construction along ROWs could limit access to emergency services and result in increased traffic congestion. Depending on the availability of ROWs, the installation of new poles could involve the construction of access roads, which also has the potential to impact traffic flow. Temporary disruptions to public safety telecommunications systems and current commercial communications systems could also occur as a result of the installation of new poles and hanging cables. However, public safety and commercial communication systems are likely to improve during operations given the new source of coverage that the NPSBN intends to provide. These likely substantial beneficial operational impacts are discussed below.

[2] Points of presence are connections or access points between two different networks, or different components of one network.

- Collocation on Existing Aerial Fiber Optic Plant: Replacement of poles, installation of new fiber on existing poles, and structural hardening could cause some disruptions to current telecommunications infrastructure. These activities also have the potential to temporarily disrupt current commercial communications systems. If construction is required within utility corridors, current utility systems could be affected. The transport of heavy equipment use associated with these activities could result in increased traffic congestion and could potentially impact traffic safety conditions and limited access to emergency services. The collocation on existing aerial fiber optic plant is envisioned to provide a new level of resiliency to current public safety telecommunications capabilities. Furthermore, pole replacement as a part of deployment activities could help to accommodate loads from new users. These likely substantial beneficial impacts are discussed below.
- New Build–Submarine Fiber Optic Plant: The installation of cables in limited nearshore or inland bodies of water would not impact land transportation systems, public safety telecommunications systems, commercial communications system, or land-based utility systems because there would be little to no terrestrial ground disturbance associated with this activity. Temporary impacts to telecommunications infrastructure could potentially occur as result of the construction of landings and/or facilities on shore to accept submarine cables.
- Installation of Optical Transmission or Centralized Transmission Equipment: If installation of transmission equipment would occur in existing boxes or huts and require minimal construction, there would likely be *no impact* to infrastructure because there would be no disturbance to existing infrastructure. Fiber installation activities could require additional installation of equipment to enhance the digital signals traveling through the fiber, which could interfere with the existing telecommunication services. Transmission equipment such as small boxes or huts is typically installed in the ROW of the utility corridor. Construction activities involving excavation could potentially impact utility services. Depending on the availability of a public ROW, construction of a new access road could be necessary, which has the potential to impact transportation capacity and safety. However, these potential impacts are expected to be minor and temporary.

- Wireless Projects
  - New Wireless Communication Towers: Installation of new wireless towers and associated structures (generators, equipment sheds, fencing, security and aviation lighting, electrical feeds, and concrete foundations and pads) or access roads might result in temporary or unintended impacts to current public safety telecommunications systems, commercial communications systems, or utility service during installation or interconnection activities. Generally, however, these deployment activities would be independent and would not be expected to interfere with other existing towers and structures. Transport of heavy equipment during these activities, construction that occurs within the public road ROW, and construction of new access roads could result in

temporary impacts to transportation capacity and safety and could limit access to emergency services.

- Collocation on Existing Wireless Tower, Structure, or Building: Collocation would involve mounting or installing equipment (such as antennas or microwave dishes) on an existing tower, installation of power units, and structural hardening on existing towers and structures. These activities are not likely to impact transportation system capacity and safety or access to emergency services; however, there is a possibility that these activities could result in temporary interruptions to the existing public safety telecommunications infrastructure, current communications systems, and electric power utilities. Collocation on existing wireless towers, structures, or buildings would likely improve disaster resistance and resiliency and increase the capacity of the system to accommodate the load from new users. These likely substantial beneficial impacts are discussed below.

- Deployable Technologies
  - Deployable land-based technologies including Cell on Wheels, Cell on Light Truck, and System on Wheels are comprised of cellular base stations (sometimes with expandable antenna masts) and generators that connect to utility power cables. Connecting the generators to utility power cables has the potential to disrupt electric power utility systems or cause power outages; however, this is expected to be temporary and minor. Use of Deployable Aerial Communications Architecture (such a drones, piloted aircraft, balloons, and blimps) as well as land-based deployable technologies mentioned above could require staging or landing areas (depending on the type of technology). These staging or landing areas require minor construction and maintenance within public road ROWs and utility corridors, heavy equipment movement, minor excavation and paving near public roads, which have the potential to impact transportation capacity and safety as these activities could increase transportation congestion and delays. Implementation of deployable technologies could help to provide coverage in rural and urban areas of Puerto Rico where permanent, fixed infrastructure cannot be erected due to a variety of factors such as severe weather conditions or rugged terrain. Likely substantial beneficial impacts associated with operation of the Preferred Alternative are discussed below.
- Satellites and Other Technologies
  - Satellite-Enabled Devices and Equipment: The installation of permanent equipment on existing structures and the use of portable devices that use satellite technology have the potential to temporarily interfere with existing public safety telecommunications systems and current commercial communications systems. Given that construction activities would occur on existing structures, transportation capacity and safety and access to emergency services would not be impacted.

In general, most of the above-mentioned activities could potentially involve trenching or directional boring, construction of access roads, huts, and installation of equipment such as antennas or microwave dishes and specially sealed cables in nearshore waters and inland waterbodies, and/or heavy equipment movement. Potential impacts to telecommunications infrastructure associated with deployment of this infrastructure could include increased traffic congestion interruptions to existing telecommunication systems, increased emergency response times, reductions in emergency levels of service, and utility interruptions. These potential impacts would generally be minor and temporary, and associated BMPs and mitigation measures to help avoid or reduce these impacts are described further in Chapter 11.

Potential Transportation System Capacity and Safety Impacts

Based on the analysis of the deployment activities described above, potential impacts to transportation system capacity and safety as a result of transport of heavy equipment, road blockages, and excavation activities are anticipated to be *less than significant* at the programmatic level (see Table 8.2.1-1). See Chapter 11, BMPs and Mitigation Measures, for a listing of BMPs and mitigation measures that FirstNet and/or their partners would require, as practicable or feasible, to help avoid or minimize potential impacts.

Potential Impacts to the Accessibility of Local Health, Public Safety, and Emergency Response Services

Based on the analysis of proposed activities described above, potential impacts to local health, public safety, and emergency response times are considered to be *less than significant* at the programmatic level (see Table 8.2.1-1). See Chapter 11, BMPs and Mitigation Measures, for a listing of BMPs and mitigation measures that FirstNet and/or their partners would require, as practicable or feasible, to help avoid or minimize potential impacts associated with infrastructure.

Potential Public Safety Telecommunication and Infrastructure Impacts

Based on the analysis of proposed activities described above, potential impacts to public safety telecommunications are considered to be *less than significant* at the programmatic level (see Table 8.2.1-1). See Chapter 11, BMPs and Mitigation Measures, for a listing of BMPs and mitigation measures that FirstNet and/or their partners would require, as practicable or feasible, to help avoid or minimize potential impacts.

Potential Commercial Telecommunication System Level of Service Impact

Based on the analysis of the proposed activities described above, potential impacts to the current commercial telecommunication system level of service are anticipated to be *less than significant* at the programmatic level (see Table 8.2.1-1). See Chapter 11, BMPs and Mitigation Measures, for a listing of BMPs and mitigation measures that FirstNet and/or their partners would require, as practicable or feasible, to help avoid or minimize potential impacts.

Potential Utility Service Impacts

Based on the analysis of the proposed activities described above, potential impacts to utility services are anticipated to be *less than significant* at the programmatic level (see Table 8.2.1-1). See Chapter 11, BMPs and Mitigation Measures, for a listing of BMPs and mitigation measures that FirstNet and/or their partners would require, as practicable or feasible, to help avoid or minimize potential impacts.

Potential Operation Impacts

As described in Section 2.1.2, Proposed Action Infrastructure, operation activities associated with the Preferred Alternative would consist of routine maintenance and inspection of the facilities. Any major infrastructure replacement as part of ongoing system maintenance would result in potential impacts similar to the abovementioned deployment impacts. It is anticipated that there would be no adverse impacts to telecommunications infrastructure associated with routine inspections of the Preferred Alternative, assuming that the same access roads and utility ROWs used for deployment are also used for inspections. If usage of heavy equipment as part of routine maintenance or inspections occurs off of established access roads or corridors, or if further construction-related activities are required along public road and utility ROWs, increased traffic congestion, current telecommunication system interruption, and utility interruptions could result as explained above, although these potential impacts would be expected to be minor and temporary.

Numerous substantial beneficial impacts would likely be associated with operation of the NPSBN. The new system is intended to result in substantial improvements in public safety response times and the ability to communicate effectively with and between public safety entities, and would also likely result in substantial improvements in level of service and communications capabilities. Operation of the NPSBN is intended to involve high-speed data capabilities, location information, images, and eventually streaming video, which would likely significantly improve communications and the ability of the public safety community to effectively engage and respond. The NPSBN is also intended to have a higher level of redundancy and resiliency than current commercial networks to support the public safety community effectively, even in events of extreme demand. This improvement in the level of resiliency and redundancy is intended to increase the reliability of systems, communications, and level of service, and also minimize disruptions and misinformation resulting from limited or disrupted service. Finally, the NPSBN would likely improve the much-needed coverage in both rural and remote areas as well as the urban areas of Puerto Rico.

8.2.1.5. Alternatives Impact Assessment

The following section assesses potential impacts to public safety telecommunications infrastructure associated with the Deployable Technologies Alternative and the No Action Alternative.[3]

Deployable Technologies Alternative

Under the Deployable Technologies Alternative, a nationwide fleet of mobile communications systems would provide temporary coverage in areas not covered by the existing, usable infrastructure. There would be no collocation of equipment and no new construction associated

[3] As mentioned above and in Section 2.1.2, Proposed Action Infrastructure, the Preferred Alternative includes implementation of deployable technologies.

with wired or wireless projects discussed above under the Preferred Alternative. Some limited construction could be associated with implementation such as land clearing or paving for parking or staging areas. The specific infrastructure associated with the Deployable Technologies Alternative would be the same as the deployable technologies implemented as part of the Preferred Alternative but would likely be implemented in greater numbers, over a larger geographic extent, and used with greater frequency and duration. Therefore, potential impacts to Puerto Rico's infrastructure system as a result of implementation of this alternative could be as described below.

Potential Deployment Impacts

As explained above, implementation of deployable technologies could result in *less than significant* impacts at the programmatic level to telecommunications systems, commercial communications systems, and utilities if deployment occurs within public road and utility ROWs. Some staging or landing areas (depending on the type of technology) could require heavy equipment movement, excavation, or paving, which have the potential to impact transportation systems. The presence and transport of these mobile communication units could potentially increase traffic congestion and delays, increase transportation-related incidents, and limit access to emergency services. However, implementation of deployable technologies would likely result in substantial beneficial impacts during operation, as discussed below.

Potential Operation Impacts

As explained above, operation activities would consist of implementation/running of the deployable technology and routine maintenance and inspections. As with the Preferred Alternative, it is anticipated that there would be no adverse impacts to the existing telecommunications infrastructure associated with routine inspections of the Deployable Technologies Alternative, assuming that the same access roads and utility ROWs used for deployment are also used for inspections. If usage of heavy equipment as part of routine maintenance or inspections occurs off of established access roads or utility ROWs, or if additional maintenance-related construction activities occur within public road and utility ROWs, *less than significant* impacts at the programmatic level to transportation systems, utility services, emergency-level of service, emergency response times, and access to emergency facilities could occur.

As with operations associated with the Preferred Alternative, it is likely that the operation of the Deployable Technologies Alternative would result in improvements to public safety response times and the ability to communicate effectively with and between public safety entities, and would also likely result in improvements in level of service and communications capabilities, but all these improvements would be likely temporary as opposed to the permanent substantial beneficial impacts of the Preferred Alternative. Generally, these units would be deployed at times of an incident to the affected area for either planned or unplanned incidents or events. Many of the urban and rural areas in Puerto Rico are lacking public safety telecommunications infrastructure and coverage given the complex geography and fragmented landscape. As explained above, under the Deployable Technologies Alternative, a nationwide fleet of mobile communications systems could provide temporary coverage in areas not covered by the existing, usable infrastructure, which would likely temporarily improve coverage throughout Puerto Rico.

No Action Alternative

Under the No Action Alternative, the NPSBN would not be deployed; therefore there would be no associated construction or installation of wired, wireless, deployable infrastructure or satellites and other technologies. As a result, there would be *no impacts* to infrastructure because there would be no deployment or operation of the Proposed Action; however, none of the likely substantial beneficial impacts associated with improved response times, redundancy, and resiliency of the system creating a more reliable emergency communication system would be realized. Environmental conditions would therefore be the same as those described in Section 8.1.1, Infrastructure.

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8.2.2. Soils

8.2.2.1. Introduction

This section describes potential impacts to soil resources in Puerto Rico associated with deployment and operation of the Proposed Action. Mitigation measures, as defined through permitting and/or consultation with the appropriate resource agency, would be implemented as part of deployment and operation of the Proposed Action to help avoid or reduce potential impacts to soil resources. Implementation of best management practices (BMPs), as practicable or feasible, could further reduce the potential for impacts. Both mitigation measures and BMPs are discussed in Chapter 11, BMPs and Mitigation Measures.

8.2.2.2. Impact Assessment Methodology and Significance Criteria

The potential impacts of the Proposed Action on soil resources were evaluated using the significance criteria presented in Table 8.2.2-1. As described in Section 8.2, Environmental Consequences, the categories of impacts are defined at the programmatic level as *potentially significant*, *less than significant with BMPs and mitigation measures incorporated*, *less than significant*, or *no impact*. Characteristics of each potential impact type, including magnitude or intensity, geographic extent, and duration or frequency, were used to determine the impact significance rating associated with each potential impact.

Given the nature of this programmatic evaluation, and because the Proposed Action could potentially cover a wide variety of actions that would take place in various landscapes, the potential impacts to soil resources addressed in this section are presented as a range of possible impacts.

Table 8.2.2-1: Impact Significance Rating Criteria for Soils

Type of Effect	Effect Characteristic	Impact Level			
		Potentially Significant	**Less than Significant with BMPs and Mitigation Measures Incorporated**	**Less than Significant**	**No Impact**
Soil erosion	Magnitude or Intensity	Severe, widespread, and observable erosion in comparison to baseline, high likelihood of encountering erosion-prone soils; high likelihood of encountering prime or unique farmland	Effect that is *potentially significant*, but with mitigation is *less than significant* at the programmatic level	Perceptible erosion in comparison to baseline conditions; low likelihood of encountering erosion-prone soil suborders; low likelihood of encountering prime or unique farmland	No perceptible change in baseline conditions; *no impacts* to prime or unique farmland at the programmatic level
	Geographic Extent	State or territory		Region or county	NA
	Duration or Frequency	Chronic or long-term erosion not likely to be reversed over several years		Isolated, temporary, or short-term erosion that that is reversed over few months or less	NA
Topsoil mixing	Magnitude or Intensity	Clear and widespread mixing of the topsoil and subsoil layers	Effect that is *potentially significant*, but with mitigation is *less than significant* at the programmatic level	Minimal mixing of the topsoil and subsoil layers has occurred	No perceptible evidence that the topsoil and subsoil layers have been mixed
	Geographic Extent	State or territory		Region or county	NA
	Duration or Frequency	NA		NA	NA
Soil compaction and rutting	Magnitude or Intensity	Severe and widespread, observable compaction and rutting in comparison to baseline	Effect that is *potentially significant*, but with mitigation is *less than significant* at the programmatic level	Perceptible compaction and rutting in comparison to baseline conditions	No perceptible change in baseline conditions
	Geographic Extent	State or territory		Region or county	NA
	Duration or Frequency	Chronic or long-term compaction and rutting not likely to be reversed over several years		Isolated, temporary, or short term compaction and rutting that is reversed over a few months or less	No perceptible change in baseline conditions

NA = not applicable

8.2.2.3. Description of Environmental Concerns

Terms and concepts discussed in this section are further discussed and defined in the Affected Environment section (Section 8.1.2, Soils).

Soil Erosion

One of the primary environmental concerns during construction activities is soil erosion and sedimentation. Increased sedimentation in waterways, for example, may alter natural sediment transport processes which can impair water and habitat quality and potentially affect aquatic plants and animals. Potential impacts to soils from erosion may occur in areas where the slopes are steep and where the erosion potential is moderate to severe as indicated by soil characteristics. Soil suborders exist in Puerto Rico that have steep slopes and where the erosion potential is moderate to severe, particularly in the Udalfs, Psamments, Udepts, Rendolls, Ustolls, Udox, Humults, and Udults soil suborders (see Section 8.1.2, Soils).

According to Natural Resources Conservation Service data, approximately 175,000 acres of prime farmland (less than 8 percent of the total land area) exists on the territory, so the likelihood of the Proposed Action impacting these soils is minimal. FirstNet and/or their partners would likely attempt to avoid Deployment/construction activities, as practicable or feasible, in areas with severe erosion potential and steep slopes (up to 60 percent; see Section 8.1.2, Soils). However, given steep slopes are present throughout much of Puerto Rico, some limited amount of infrastructure could be built or deployed in these areas, in which case BMPs and mitigation measures (see Chapter 11, BMPs and Mitigation Measures) could help avoid or minimize the potential impacts. In addition, it is anticipated that any soil erosion would likely be isolated within those locations and would be short-term with stability achieved after a few months or less.

Topsoil Mixing

The potential for the loss of topsoil (i.e., organic and mineral topsoil layers) by mixing would be present during construction of the proposed facilities or infrastructure and during trenching, grading, and/or foundation excavation activities. Although prime farmland soils identified in Puerto Rico make up only a small portion of the state's total landmass, topsoil mixing could result in the loss of soil productivity and fertility, as well as the loss of viable seeds and/or root mass present in prime farmland and non-prime farmland areas. It is possible that minimal topsoil mixing as a result of construction could potentially be perceptible at some buildout locations but could be reduced with implementation of BMPs and mitigation measures (see Chapter 11, BMPs and Mitigation Measures). However, it is anticipated that topsoil mixing would likely be minimal and isolated within those locations.

Soil Compaction and Rutting

The movement of heavy equipment required to support any land clearing, drilling, and construction activities, as well as installation of equipment or modification of structures needed to support network deployment, could potentially impact soil resources by causing the compaction and rutting of susceptible soils. Soils suborders with the highest potential for compaction or rutting resulting from heavy equipment passage were identified by using the STATSGO2 Database (see Section 8.1.2, Soils). Of the soil suborders identified in Puerto Rico, soils that are flood prone or are poorly drained likely have the greatest potential for compaction and rutting. These soils may be found within the Aquents, Saprists, Aquepts, Aquolls, Fluvents, and Psamments suborders. Although 8 of the 20 soil suborders present in Puerto Rico are flood prone or poorly drained, it is anticipated that soil compaction and rutting as a result of deployment of the Proposed Action would be temporary in nature and disturbances would be minor, isolated, and reversed in a period of a few months or less.[1] Implementation of BMPs and mitigation measures could further decrease the potential for impacts. As a result, potential impacts to soils as a result of soil compaction and rutting would likely not be perceptible at the programmatic level.

8.2.2.4. Potential Impacts of the Preferred Alternative

The following section assesses potential impacts associated with implementation of the Preferred Alternative, including deployment and operation activities.

Potential Deployment Impacts

As described in Section 2.1.2, Proposed Action Infrastructure, implementation of the Preferred Alternative could result in the deployment of various types of facilities or infrastructure. Depending on the physical nature and location of the facility/infrastructure and the specific deployment requirements, some activities would result in potential impacts to soil resources and others would not. In addition, and as explained in this section, various types of Preferred Alternative infrastructure could result in a range of *no impacts* to *less than significant* impacts at the programmatic level depending on the deployment scenario or site-specific conditions. Site-specific analysis may be required depending on the site conditions, the type of deployment, or any other permits or permissions necessary to perform the work.

Activities Likely to Have No Impacts

Of the types of facilities or infrastructure development scenarios described in Section 2.1.2, Proposed Action Infrastructure, the following are likely to have *no impacts* to soil resources at the programmatic level under the conditions described below:

- Wired Projects
  - Use of Existing Conduit – New Buried Fiber Optic Plant: Disturbance associated with the installation of fiber optic cable in existing conduit would be limited to entry and exit points of the existing conduit in previously disturbed areas. It is anticipated that there would be *no impacts* to soil resources at the programmatic level because the activities that would be conducted at these small entry and exit points are not likely to produce perceptible changes.

[1] Although deployable technologies could be in place for a period of several years, potential impacts are still expected to range from *no impact* (if placed on a previously paved surface) to *less than significant* at the programmatic level. See below.

  - Use of Existing Buried or Aerial Fiber Optic Plant or Existing Submarine Cable: Lighting up of dark fiber would have *no impacts* to soil resources because there would be no ground disturbance.
- Satellites and Other Technologies
  - Satellite-Enabled Devices and Equipment: It is anticipated that the installation of permanent equipment on existing structures and the use of portable devices that use satellite technology would not impact soil resources because those activities would not require ground disturbance.
  - Deployment of Satellites: FirstNet does not anticipate launching satellites as part of the deployment of the nationwide public safety broadband network (NPSBN); however, it could include equipment on satellites that are already being launched for other purposes. As adding equipment to an existing launch vehicle would not impact soils resources, it is anticipated that this activity would have *no impact* on soil resources.

Activities with the Potential to Have Impacts

Potential deployment-related impacts to soil resources as a result of implementation of the Preferred Alternative would encompass a range of potential impacts that could occur as a result of ground disturbance activities, including soil erosion, topsoil mixing, and soil compaction and rutting. The types of infrastructure development scenarios or deployment activities that could be part of the Preferred Alternative and result in potential impacts to soil resources include the following:

- Wired Projects
  - New Build – Buried Fiber Optic Plant: Plowing (including vibratory plowing), trenching, or directional boring and the construction of points of presence,[2] huts, or other associated facilities or hand-holes to access fiber could result in potential impacts to soil resources. Soil disturbance and heavy equipment use associated with plowing, trenching, or directional boring as well as land/vegetation clearing, excavation activities, and landscape grading associated with construction of points of presence, huts, or other associated facilities or hand-holes to access fiber could result in soil erosion, topsoil mixing, soil compaction and rutting.
  - New Build – Aerial Fiber Optic Plant: Topsoil removal, soil excavation, and excavated material placement during the installation of new poles could result in soil erosion and topsoil mixing. The use of heavy equipment during the installation of new poles and hanging of cables could result in soil compaction and rutting.
  - Collocation on Existing Aerial Fiber Optic Plant: Topsoil removal, soil excavation, and excavated material placement during the replacement of poles and structural hardening could result in soil erosion and topsoil mixing. Heavy equipment use associated with

[2] Points of presence are connections or access points between two different networks, or different components of one network.

these activities as well as with installing new fiber on existing poles could result in soil compaction and rutting.

  - New Build – Submarine Fiber Optic Plant: The installation of cables in limited near-shore or inland bodies of water would not impact soil resources because there would be no ground disturbance associated with this activity (see Section 8.2.4, Water Resources, for a discussion of potential impacts to water resources). However, impacts to soil resources could potentially occur as result of the construction of landings and/or facilities on shore to accept submarine cable. Soil erosion and topsoil mixing could potentially occur as result of grading, foundation excavation, or other ground disturbance activities. Soil compaction and rutting could potentially occur due to heavy equipment use during these activities.
  - Installation of Optical Transmission or Centralized Transmission Equipment: If installation of transmission equipment would occur in existing boxes or huts and require no ground disturbance, there would be *no impacts* to soils. If installation of transmission equipment required grading or other ground disturbance to install small boxes, huts, or access roads, there could potentially be impacts to soils. Such ground disturbance could result in soil erosion and topsoil mixing. Heavy equipment use could result in soil compaction and rutting.

- Wireless Projects
  - New Wireless Communication Towers: Installation of new wireless towers and associated structures (generators, equipment sheds, fencing, security and aviation lighting, electrical feeds, and concrete foundations and pads) or access roads could result in potential impacts to soil resources. Land/vegetation clearing, excavation activities, landscape grading, and other ground disturbance activities during the installation of new wireless towers and associated structures or access roads could result in soil erosion or topsoil mixing, and heavy equipment use during these activities could result in soil compaction and rutting.
  - Collocation on Existing Wireless Tower, Structure, or Building: Collocation would involve mounting or installing equipment (such as antennas or microwave dishes) on an existing structure, and would not result in impacts to soils because there would be no ground disturbance associated with this activity. The potential addition of power units, structural hardening, and physical security measures would not impact soil resources if this activity would not require ground disturbance. However, if structural hardening and physical security measures require ground disturbance, such as grading or excavation activities, impacts to soil resources could occur, including soil erosion and topsoil mixing, as well as soil compaction and rutting associated with heavy equipment use.
- Deployable Technologies
  - Where deployable technologies, both land-based and aerial, would be located on existing paved surfaces and the acceptable load on those paved surfaces is not exceeded, it is anticipated that there would be *no impacts* to soil resources because there would be no

ground disturbance. However, implementation of deployable technologies could result in potential impacts to soil resources if deployment of land-based deployables occurs in unpaved areas, or if the implementation results in minor construction or paving of previously unpaved surfaces. In addition, potential impacts to soils could occur on paved surfaces if the acceptable load of the surface is exceeded. Some staging areas could require land/vegetation clearing, minor excavation, and paving. These activities could result in soil erosion and topsoil mixing. Heavy equipment use associated with these activities could result in soil compaction and rutting. In addition, implementation of and activities associated with deployable technologies themselves could also result in soil compaction and rutting if deployed in unpaved areas.

In general, the abovementioned activities could potentially involve land/vegetation clearing, topsoil removal, excavation, excavated material placement, trenching or directional boring, construction of access roads and other impervious surfaces, landscape grading, and heavy equipment movement. Potential impacts to soil resources at the programmatic level associated with deployment of this infrastructure could include soil erosion, topsoil mixing, and/or soil compaction and rutting. These potential impacts are described further below, and BMPs and mitigation measures to help avoid or reduce these potential impacts are discussed in Chapter 11, BMPs and Mitigation Measures.

Potential Soil Erosion Impacts

Based on the analysis of the deployment activities described above to soil resources, potential impacts as a result of erosion are anticipated to be *less than significant* at the programmatic level. See Chapter 11 for a listing of BMPs and mitigation measures that FirstNet and/or their partners would require, as practicable or feasible, to help avoid or minimize potential soil erosion impacts.

Potential Topsoil Mixing Impacts

Based on the analysis of proposed activities described above, the minimal mixing of the topsoil with the subsoil layers could result in potentially *less than significant* impacts at the programmatic level. See Chapter 11 for a listing of BMPs and mitigation measures that FirstNet and/or their partners would require, as practicable or feasible, to help avoid or minimize potential soil erosion impacts.

Potential Soil Compaction and Rutting Impacts

Based on the analysis of the proposed activities described above to soil resources, potential impacts to soil resources as a result of soil compaction and rutting are anticipated to be *less than significant* at the programmatic level. See Chapter 11 for a listing of BMPs and mitigation measures that FirstNet and/or their partners would require, as practicable or feasible, to help avoid or minimize potential soil erosion impacts.

Potential Operation Impacts

As described in Section 2.1.2, Proposed Action Infrastructure, operation activities associated with the Preferred Alternative would consist of routine maintenance and inspection of the facilities. Any major infrastructure replacement as part of ongoing system maintenance would result in potential impacts similar to the abovementioned potential construction impacts. It is anticipated that there would be *no impacts* to soil resources associated with routine inspections of the Preferred Alternative, assuming that the same access roads used for deployment are also used for inspections. If usage of heavy equipment as part of routine maintenance or inspections occurs off of established access roads or corridors, or if the acceptable load of the surface is exceeded, *less than significant* soil compaction and rutting impacts could potentially result, similar to the abovementioned deployment impacts, although impacts would likely be lesser in magnitude and extent.

8.2.2.5. Alternatives Impact Assessment

The following section assesses potential impacts to soils associated with the Deployable Technologies Alternative and the No Action Alternative.[3]

Deployable Technologies Alternative

Under the Deployable Technologies Alternative option, a nationwide fleet of mobile land-based and aerial communications systems would provide temporary coverage in areas not covered by the existing, usable infrastructure. There would be no collocation of equipment and no new construction associated with wired or wireless projects discussed above under the Preferred Alternative. Some limited construction could be associated with implementation such as land clearing or paving for parking or staging areas. The specific infrastructure associated with the Deployable Technologies Alternative would be the same as the deployable technologies implemented as part of the Preferred Alternative but would likely be implemented in greater numbers, over a larger geographic extent, and used with greater frequency and duration. Therefore, potential impacts to soil resources at the programmatic level as a result of implementation of this alternative are anticipated as described below.

Potential Deployment Impacts

As explained above, implementation of land-based deployable technologies could result in *less than significant impacts* to soil resources at the programmatic level if deployment occurs in unpaved areas, or if the implementation results in paving of previously unpaved surfaces. In addition, potential impacts to soils could occur on paved surfaces if the acceptable load of the surface is exceeded. Some staging areas could require land/vegetation clearing, excavation, and paving. These activities could result in soil erosion and topsoil mixing. Heavy equipment use associated with these activities could result in soil compaction and rutting. Additionally, implementation of and activities associated with deployable technologies themselves could also result in soil compaction and rutting if deployed in unpaved areas. However, due to the limited

[3] As mentioned above and in Section 2.1.2, Proposed Action Infrastructure, the Preferred Alternative includes implementation of deployable technologies.

geographic extent of individual deployment locations, each of these impacts would still be *less than significant*.

Potential Operation Impacts

As explained above, operation activities would consist of implementation/running of the deployable technology and routine maintenance and inspections. As with the Preferred Alternative, it is anticipated that there would be *no impacts* to soil resources associated with routine inspections of the Deployable Technologies Alternative, assuming that the same access roads used for deployment are also used for inspections. If usage of heavy equipment as part of routine maintenance or inspections occurs off of established access roads or corridors, or if the acceptable load of the surface is exceeded, *less than significant* soil compaction and rutting impacts at the programmatic level could potentially result, similar to the abovementioned deployment impacts. Finally, if deployable technologies are parked and operated with air conditioning for extended periods of time, the condensation water from the air conditioner could result in soil erosion as it runs onto the soil below. However, it is anticipated that the soil erosion would not result in perceptible changes to baseline conditions.

No Action Alternative

Under the No Action Alternative, the NPSBN would not be deployed; therefore there would be no associated construction or installation of wired, wireless, deployable infrastructure or satellites and other technologies. As a result, there would be *no impacts* to soil resources because there would be no deployment or operation of the Proposed Action. Environmental conditions would therefore be the same as those described in Section 8.1.2, Soils.

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8.2.3. Geology

8.2.3.1. Introduction

This section describes potential impacts to geologic resources in Puerto Rico associated with deployment and operation of the Proposed Action as well as the geologic hazards that could potentially affect the Proposed Action. Mitigation measures, as defined through permitting and/or consultation with the appropriate resource agency, would be implemented as part of deployment and operation of the Proposed Action to help avoid or reduce potential impacts to geologic resources and geological hazards that could affect the Proposed Action. Implementation of best management practices (BMPs), as practicable or feasible, could further reduce the potential for impacts. Both mitigation measures and BMPs are discussed in Chapter 11, BMPs and Mitigation Measures.

8.2.3.2. Impact Assessment Methodology and Significance Criteria

The potential impacts of the Proposed Action on geologic resources and the potential impacts to the Proposed Action from geologic hazards were evaluated using the significance criteria presented in Table 8.2.3-1. As described in Section 8.2, Environmental Consequences, the categories of impacts are defined at the programmatic level as *potentially significant*, *less than significant with BMPs and mitigation measures incorporated*, *less than significant*, or *no impact*. Characteristics of each impact type, including magnitude or intensity, geographic extent, and duration or frequency, were used to determine the impact significance rating associated with each potential impact.

Given the nature of this programmatic evaluation, and because the Proposed Action could potentially cover a wide variety of actions that would take place in various landscapes, the potential impacts to geologic resources addressed in this section are presented as a range of possible impacts.

Table 8.2.3-1: Impact Significance Rating Criteria for Geology

Type of Effect	Effect Characteristic	Impact Level			
		Potentially Significant	**Less than Significant with BMPs and Mitigation Measures Incorporated**	**Less than Significant**	**No Impact**
Surface geology, bedrock, topography, physiography, and geomorphology impacts	Magnitude or Intensity	Substantial and measurable degradation or alteration of surface geology, bedrock, topography, physiographic characteristics, or geomorphological processes	Effect that is *potentially significant*, but with BMPs and mitigation measures is *less than significant* at the programmatic level	Minor degradation or alteration of surface geology, bedrock, topography that does not result in measurable changes in physiographic characteristics or geomorphological processes	No degradation or alteration of surface geology, bedrock, topography, physiographic characteristics, or geomorphologic processes
	Geographic Extent	State or territory		State or territory	NA
	Duration or Frequency	Permanent or long-term changes to characteristics and processes		Temporary degradation or alteration of resources that is limited to the construction and deployment phase	NA
Mineral and fossil fuel resource impacts	Magnitude or Intensity	Severe, widespread, observable impacts to mineral and/or fossil fuel resources	Effect that is *potentially significant*, but with BMPs and mitigation measures is *less than significant* at the programmatic level	Limited impacts to mineral and/or fossil resources	No perceptible change in mineral and/or fossil fuel resources
	Geographic Extent	Regions of mineral or fossil fuel extraction areas are highly prevalent within the state or territory		Mineral or fossil fuel extraction areas occur within the state or territory, but may be avoidable	Mineral or fossil fuel extraction areas do not occur within the state or territory
	Duration or Frequency	Long-term or permanent degradation or depletion of mineral and fossil fuel resources		Temporary degradation or depletion of mineral and fossil fuel resources	NA

Type of Effect	Effect Characteristic	Impact Level			
		Potentially Significant	**Less than Significant with BMPs and Mitigation Measures Incorporated**	**Less than Significant**	**No Impact**
Paleontological resources impacts	Magnitude or Intensity	Severe, widespread, observable impacts to paleontological resources	Effect that is *potentially significant*, but with BMPs and mitigation measures is *less than significant* at the programmatic level	Limited impacts to paleontological and/or fossil resources	No perceptible change in baseline conditions
	Geographic Extent	Areas with known paleontological resources are highly prevalent within the state or territory		Areas with known paleontological resources occur within the state or territory, but may be avoidable	Areas with known paleontological resources do not occur within the state or territory
	Duration or Frequency	NA		NA	NA
Seismic hazards	Magnitude or Intensity	High likelihood that a project activity could be located within a high-risk earthquake hazard zone or active fault	Effect that is *potentially significant*, but with BMPs and mitigation measures is *less than significant* at the programmatic level	Low likelihood that a project activity could be located within an earthquake hazard zone or active fault	No likelihood of a project activity being located in an earthquake hazard zone or active fault
	Geographic Extent	Hazard zones or active faults are highly prevalent within the state or territory		Earthquake hazard zones or active faults occur within the state or territory, but may be avoidable	Earthquake hazard zones or active faults do not occur within the state or territory
	Duration or Frequency	NA		NA	NA
Volcanic activity	Magnitude or Intensity	High likelihood that a project activity could be located near a volcano lava or mud flow area of influence	Effect that is *potentially significant*, but with BMPs and mitigation measures is *less than significant* at the programmatic level	Low likelihood that a project activity could be located near a volcanic ash area of influence	No likelihood of a project activity located within a volcano hazard zone
	Geographic Extent	Volcano lava flow areas of influence are highly prevalent within the state or territory		Volcano ash areas of influence occur within the state or territory, but may be avoidable	Volcano hazard zones do not occur within the state or territory
	Duration or Frequency	NA		NA	NA

Type of Effect	Effect Characteristic	Impact Level			
		Potentially Significant	**Less than Significant with BMPs and Mitigation Measures Incorporated**	**Less than Significant**	**No Impact**
Landslides	Magnitude or Intensity	High likelihood that a project activity could be located within a landslide area	Effect that is *potentially significant*, but with BMPs and mitigation measures is *less than significant* at the programmatic level	Low likelihood that a project activity could be located within a landslide area	No likelihood of a project activity located within a landslide hazard area
	Geographic Extent	Landslide areas are highly prevalent within the state or territory		Landslide areas occur within the state or territory, but may be avoidable	Landslide hazard areas do not occur within the state or territory
	Duration or Frequency	NA		NA	NA
Land subsidence	Magnitude or Intensity	High likelihood that a project activity could be located within an area with a hazard for subsidence (e.g., karst terrain, lava tubes, etc.)	Effect that is *potentially significant*, but with BMPs and mitigation measures is *less than significant* at the programmatic level	Low likelihood that a project activity could be located within an area with a hazard for subsidence (e.g., karst terrain, lava tubes, etc.)	Project activity located outside an area with a hazard for subsidence (e.g., karst terrain, lava tubes, etc.)
	Geographic Extent	Areas with a high hazard for subsidence (e.g., karst terrain, lava tubes, etc.) are highly prevalent within the state or territory		Areas with a high hazard for subsidence (e.g., karst terrain, lava tubes, etc.) occur within the state or territory, but may be avoidable	Areas with a high hazard for subsidence (e.g., karst terrain, lava tubes, etc.) do not occur within the state or territory
	Duration or Frequency	NA		NA	NA

NA = not applicable

8.2.3.3. Description of Environmental Concerns

Terms and concepts discussed in this section are further discussed and defined in the Affected Environment section (Section 8.1.3, Geology).

Potential Effects from the Proposed Action

Potential Surface Geology, Bedrock, Topography, Physiography, and Geomorphology Impacts

The potential for impacts to surface geology, bedrock, topography, physiography, and geomorphology could be present during deployment or construction of the proposed facilities/infrastructure, particularly during trenching, grading, and/or foundation excavation activities. For example, as discussed in in Section 8.1.2, Soils, there are numerous areas in Puerto Rico where shallow soils are present and bedrock is likely at or near the surface, particularly in the Humid Mountains and Valleys and Semiarid Mountains and Valleys regions. Such shallow bedrock could be susceptible to potential impacts from rock ripping.[1] However, rock ripping would likely only occur in discrete locations where necessary and would not result in large-scale changes to Puerto Rico's geologic, topographic, or physiographic characteristics. In addition, to the extent practicable or feasible, FirstNet and/or their partners would work to avoid areas that commonly undergo significant geomorphological changes, such as active stream or river channels. Temporary degradation or alteration of surface geology, bedrock, topography, physiography, and geomorphology would primarily be limited to the construction/deployment phases and would be limited and localized in extent. Therefore, it is anticipated that potential impacts to surface geology, bedrock, topography, physiography, and geomorphology as a result of the anticipated project activities would be minor and would not result in measureable changes. Implementation of BMPs and mitigation measures would help further reduce potential impacts.[2]

Potential Mineral and Fossil Fuel Resource Impacts

In general, potential impacts to mineral and fossil fuel resources as a result of the Proposed Action would be more likely in states or territories with numerous extraction areas. Puerto Rico does not produce petroleum, natural gas, or coal and ranked 49th out of the 50 states in non-fuel mineral production (*USGS 2015; EIA 2016*).[3] Because of this, no impacts to fossil fuel resources could occur as a result of the Proposed Action. Any potential impacts would only be to mineral resources and are likely to be minor and temporary, and could be further reduced with implementation of BMPs and mitigation measures, as discussed in Chapter 11, BMPs and Mitigation Measures.

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[1] Rock ripping refers to the breakup and removal of rock material with heavy equipment such as an excavator.

[2] See Chapter 11 for a discussion of specific required BMPs and mitigation measures.

[3] See Section 8.1.3, Geology, for a map showing the primary mineral production areas and a discussion of mineral and fossil fuel resources.

Potential Paleontological Resources[4] Impacts

The potential for impacts to paleontological resources could be present during deployment or construction of the proposed facilities/infrastructure, particularly during trenching, grading, and/or foundation excavation activities. As discussed in detail in Section 8.1.3, Geology, the San Sebastian formation, which is exposed at the surface in the northeast and north-central portions of Puerto Rico, contains numerous plant and animal fossils and is known for well-preserved mollusk shells. In addition, the Aguada Limestone formation in northwestern Puerto Rico also contains fossil beds, including preserved oysters. Other formations throughout the territory may also yield fossil resources. However, it is anticipated that potential impacts to specific areas with known significant paleontological resources would be avoided, minimized, or mitigated and any potential impacts would likely be limited and localized. Site-specific analysis may be required depending on the site conditions, the type of deployment, or any other permits or permissions necessary to perform the work. Implementation of the BMPs and mitigation measures as discussed in Chapter 11, BMPs and Mitigation Measures, could help further reduce potential impacts.

Potential Effects to the Proposed Action

Seismic Hazards

As discussed in Section 8.1.3, Geology, Puerto Rico is located near the North American and Caribbean Plate boundary, and the movement and friction along the plate boundary and other associated fault systems is primarily responsible for earthquake activity. The great majority of the territory has a moderate seismic hazard risk. The Proposed Action is unlikely to affect seismic activity, but rather seismic hazards could have the potential to impact the Proposed Action. As discussed in Chapter 1, Introduction, the FirstNet network would be “hardened” from the physical, user access, and cyber security perspectives to be more resilient to potential impacts than typical telecommunications infrastructure. However, some potential impacts to the Proposed Action infrastructure could occur during significant earthquake events. It is anticipated that FirstNet and/or their partners would attempt, as practicable or feasible, to design the network to reasonably withstand the seismic activity typical in Puerto Rico, thereby limiting potential impacts. In addition, implementation of the BMPs and mitigation measures as discussed in Chapter 11, BMPs and Mitigation Measures, could help further reduce potential impacts.

Volcanic Activity

As discussed in Section 8.1.3, Geology, there are no active volcanoes in Puerto Rico. Therefore, based on the significance criteria presented in Table 8.2.3-1, there would be *no impacts* to the Proposed Action as a result of volcanic activity.

[4] Paleontological resources, or fossils, are the physical remains of plants and animals that have mineralized into, or left impressions in, solid rock or sediment.

Landslides

In general, the Proposed Action is unlikely to affect landslide activity, but rather landslides in Puerto Rico have the potential to impact the Proposed Action. As discussed in Section 8.1.3, Geology, excessive rainfall, seismic activity, and volcanic activity can trigger local landslides, especially near areas with steep slopes and loose or unconsolidated material. As discussed in Section 8.1.2, Soils, slopes in Puerto Rico range from 0 to 60 percent, with steepest areas located in the mountainous central regions.[5]

To the extent practicable or feasible, FirstNet and/or their partners would work to avoid developing and deploying telecommunications infrastructure in areas with steep slopes that are highly susceptible to landslides. Although some localized, limited potential impacts could occur as a result of landslides, widespread potential impacts are unlikely. Implementation of the BMPs and mitigation measures as discussed in Chapter 11, BMPs and Mitigation Measures, could help further reduce potential impacts.

Land Subsidence

As discussed in Section 8.1.3, Geology, limestone rocks at or near the land surface are primarily located in Puerto Rico near the northwest and north-central portions of the main island, and these areas are characterized as having abundant and very large sinkholes. The landmass of Isla de Mona, the large Puerto Rican island west of the main island, consists almost entirely of karst topography. To the extent practicable or feasible, FirstNet and/or their partners would either work to avoid areas with a high hazard for subsidence during deployment and operation activities or utilize alternate construction methods to avoid or reduce potential impacts. Implementation of the BMPs and mitigation measures discussed in Chapter 11 could help avoid or further minimize potential impacts to the Proposed Action as a result of land subsidence.

8.2.3.4. Potential Impacts of and to the Preferred Alternative

The following section assesses potential impacts associated with implementation of the Preferred Alternative, including deployment and operation activities as well as potential geologic hazards to the Preferred Alternative.

Potential Deployment Impacts

As described in Section 2.1.2, Proposed Action Infrastructure, implementation of the Preferred Alternative could result in the deployment of various types of facilities or infrastructure. Depending on the physical nature and location of the facility/infrastructure and the specific deployment requirements, some activities would result in potential impacts to geologic resources and others would not. In addition, and as explained in this section, the various types of Preferred Alternative infrastructure could result in a range of *no impacts* to *less than significant* impacts at the programmatic level depending on the deployment scenario or site-specific conditions. Site-specific analysis may be required depending on the site conditions, the type of deployment, or any other permits or permissions necessary to perform the work. Additionally, geologic hazards

[5] See Section 8.1.2, Soils, for a description of soil types and their associated slope values.

such as earthquakes, landslides, and land subsidence that have the potential to impact the deployment of the Preferred Alternative are discussed below.

Activities Likely to Have No Impacts

Of the types of facilities or infrastructure development scenarios described in Section 2.1.2, Proposed Action Infrastructure, the following are likely to have *no impacts* at the programmatic level to geologic resources under the conditions described below:

- Wired Projects
  - Use of Existing Conduit – New Buried Fiber Optic Plant: Disturbance associated with the installation of fiber optic cable in existing conduit would be limited to entry and exit points of the existing conduit in previously disturbed areas. It is anticipated that there would be *no impacts* to geologic resources because the activities that would be conducted at these small entry and exit points are not likely to produce perceptible changes.
  - Use of Existing Buried or Aerial Fiber Optic Plant or Existing Submarine Cable: Lighting up of dark fiber would have no impacts to geologic resources because there would be no ground disturbance.
- Satellites and Other Technologies
  - Deployment of Satellites: FirstNet does not anticipate launching satellites as part of the deployment of the nationwide public safety broadband network (NPSBN); however it could include equipment on satellites that are already being launched for other purposes. As adding equipment to an existing launch vehicle would not impact geologic resources, it is anticipated that this activity would have *no impact* on geologic resources.

Activities and Geologic Hazards with the Potential to Have Impacts

Potential deployment-related impacts to geologic resources as a result of implementation of the Preferred Alternative would encompass a range of potential impacts that could occur as a result of ground disturbance activities including potential impacts to surface geology, bedrock, topography, physiography, and geomorphology; potential mineral impacts; and potential paleontological impacts. In addition, geologic hazards including seismic activity, landslides, and land subsidence have the potential to impact deployment of the Preferred Alternative. The types of infrastructure development scenarios or deployment activities that could be part of the Preferred Alternative and result in potential impacts to geologic resources, or potential impacts from geologic hazards, include the following:

- Wired Projects
  - New Build – Buried Fiber Optic Plant: Plowing (including vibratory plowing), trenching, or directional boring and the construction of points of presence (POPs),[6] huts, or other associated facilities or hand-holes to access fiber could result in potential impacts to geologic resources. Ground disturbance and heavy equipment use associated with

[6] POPs are connections or access points between two different networks, or different components of one network.

plowing, trenching, directional boring, excavation activities, rock ripping, and landscape grading associated with construction of points of presence, huts, or other associated facilities or hand-holes to access fiber could result in limited potential impacts to bedrock, topography, physiography, and geomorphology; potential mineral impacts; and potential paleontological impacts. Depending on its location, this development scenario could also potentially be impacted by geologic hazards including seismic activity, landslides, and/or land subsidence if it occurs in areas of high susceptibility.

- New Build – Aerial Fiber Optic Plant: Depending on its location and deployment methods used, excavation and excavated material placement, trenching, grading, and rock ripping during the installation of new poles or construction of POPs, huts, or other facilities could result in potential limited and localized impacts to bedrock, topography, physiography, and geomorphology; potential mineral impacts; and potential paleontological impacts. This development scenario could also potentially be impacted by geologic hazards including seismic activity, landslides, and/or land subsidence, if it occurs in areas of high susceptibility.
- Collocation on Existing Aerial Fiber Optic Plant: Depending on its location, excavation, grading, and rock ripping during the replacement of poles and structural hardening could result in localized potential impacts to bedrock, topography, physiography, and geomorphology; potential mineral and fossil fuel impacts; and potential paleontological impacts. This development scenario could also potentially be impacted by geologic hazards including seismic activity, landslides, and/or land subsidence, depending on deployment location and its susceptibility to those hazards.
- New Build – Submarine Fiber Optic Plant: The installation of cables in near-shore or inland bodies of water would not impact geologic resources. However, potential impacts to geologic resources could potentially occur as result of the construction of landings and/or facilities on shore to accept submarine cable. Grading, foundation excavation, rock ripping, or other ground disturbance activities could result in limited potential impacts to bedrock, topography, physiography, and geomorphology; potential mineral; and potential paleontological impacts. Deployment of this development scenario could also potentially be impacted by geologic hazards including seismic activity, landslides, and/or land subsidence if it occurs in areas of high susceptibility.
- Installation of Optical Transmission or Centralized Transmission Equipment: If installation of transmission equipment would occur in existing boxes or huts and require no ground disturbance, there would be no impacts to geologic resources. If installation of transmission equipment required grading, foundation excavation or other ground disturbance activities including rock ripping to install small boxes, huts, or access roads, there could potentially be temporary impacts to geologic resources. Deployment of this development scenario could also potentially be impacted by geologic hazards including seismic activity, landslides, and/or land subsidence if it occurs in areas of high susceptibility.

- Wireless Projects
  - New Wireless Communication Towers: Installation of new wireless towers and associated structures (generators, equipment sheds, fencing, security and aviation lighting, electrical feeds, and concrete foundations and pads) or access roads could result in potential impacts to geologic resources. Excavation activities, landscape grading, rock ripping, and other ground disturbance activities during the installation of new wireless towers and associated structures or access roads could result in potential localized impacts to bedrock, topography, physiography, and geomorphology; potential mineral and fossil fuel impacts; and potential paleontological impacts. Deployment of this development scenario could also potentially be impacted by geologic hazards including seismic activity, landslides, and/or land subsidence if it occurs in areas of high susceptibility.
  - Collocation on Existing Wireless Tower, Structure, or Building: Collocation would involve mounting or installing equipment (such as antennas or microwave dishes) on an existing tower, which would not result in impacts to geologic resources because there would be no ground disturbance associated with this activity. The potential addition of power units, structural hardening, and physical security measures would not impact geologic resources if this activity would not require ground disturbance. However, if structural hardening required ground disturbance, such as grading, excavation activities, or rock ripping, potential impacts to geological resources could occur. Deployment of this development scenario could also potentially be impacted by geologic hazards including seismic activity, landslides, and/or land subsidence if it occurs in areas of high susceptibility.
- Deployable Technologies:
  - Where deployable technologies (both land-based and aerial) would be located or deployed on existing paved surfaces, it is anticipated that there would be no impacts to geologic resources because there would be no new ground disturbance. However, implementation of deployable technologies could result in potential impacts to geologic resources. These potential impacts could occur if deployment of land-based or aerial deployables occurs in unpaved areas, or if the implementation results in minor construction, paving of previously unpaved surfaces, grading, excavation, or rock ripping (e.g., for staging or launching/landing areas).
- Satellites and Other Technologies
  - Satellite-Enabled Devices and Equipment: It is anticipated that the installation of permanent equipment on existing structures and the use of portable devices that use satellite technology would not impact geologic resources because those activities would not require ground disturbance or cause any impact to the built or natural environment. However, where equipment is permanently installed in locations that are susceptible to specific geologic hazards, such as earthquakes, it is possible that they could be affected by that hazard.

In general, the abovementioned activities could potentially involve excavation, rock ripping, trenching or directional boring, and landscape grading. Potential impacts to geologic resources associated with deployment of this infrastructure could include potential localized and/or limited impacts to bedrock, topography, physiography, and geomorphology; mineral; and paleontological resources. Additionally, deployment of the abovementioned scenarios could be impacted by geologic hazards including seismic activity, landslides, and/or land subsidence if it occurs in areas of high susceptibility. These potential impacts are described further below. BMPs and mitigation measures that could help avoid or reduce these potential impacts are discussed in Chapter 11, BMPs and Mitigation Measures.

Potential Impacts from the Preferred Alternative

Potential Surface Geology, Bedrock, Topography, Physiography, and Geomorphology Impacts

Based on the analysis of the deployment activities described above to bedrock, topography, physiography, and geomorphology, potential impacts are anticipated to be *less than significant* at the programmatic level. See Chapter 11, BMPs and Mitigation Measures, for a listing of BMPs and mitigation measures that FirstNet and/or their partners would require, as practicable or feasible, to help avoid or minimize the potential impacts to these resources.

Potential Mineral and Fossil Fuel Resource Impacts

Based on the analysis of proposed activities described above to geologic resources, potential mineral and fossil fuel resource impacts could result in potentially *less than significant* impacts at the programmatic level; however, there would be no impacts to fossil fuel resources since Puerto Rico does not produce or have any proven recoverable reserves of petroleum, natural gas, or coal. See Chapter 11, BMPs and Mitigation Measures, for a listing of BMPs and mitigation measures that FirstNet and/or their partners would require, as practicable or feasible, to help avoid or minimize the potential impacts to mineral resources.

Potential Paleontological Resources Impacts

Based on the analysis of the proposed activities described above to geological resources, potential paleontological resources impacts are anticipated to be *less than significant* at the programmatic level. However, site-specific analysis may be required depending on the site conditions, the type of deployment, or any other permits or permissions necessary to perform the work. See Chapter 11, BMPs and Mitigation Measures, for a listing of BMPs and mitigation measures that FirstNet and/or their partners would require, as practicable or feasible, to help avoid or minimize the potential impacts to paleontological resources.

Potential Impacts to the Preferred Alternative

Potential Seismic Hazard Impacts

Based on the analysis of the proposed activities described above, potential impacts to the deployment of the Preferred Alternative as a result of seismic hazards are anticipated to be *less than significant* at the programmatic level. See Chapter 11, BMPs and Mitigation Measures, for a listing of BMPs and mitigation measures that FirstNet and/or their partners would require, as practicable or feasible, to help avoid or minimize potential impacts associated with seismic hazards.

Potential Volcanic Activity Impacts

Based on the analysis of the proposed activities described above, potential impacts to the deployment of the Preferred Alternative as a result of volcanic activity are anticipated to have *no impacts*.

Potential Landslide Impacts

Based on the analysis of the proposed activities described above, potential impacts to the deployment of the Preferred Alternative as a result of landslides are anticipated to be *less than significant* at the programmatic level. See Chapter 11, BMPs and Mitigation Measures, for a listing of BMPs and mitigation measures that FirstNet and/or their partners would require, as practicable or feasible, to help avoid or minimize potential impacts associated with landslide hazards.

Potential Land Subsidence Impacts

Based on the analysis of the proposed activities described above, potential impacts to the deployment of the Preferred Alternative as a result of land subsidence are anticipated to be *less than significant* at the programmatic level. See Chapter 11, BMPs and Mitigation Measures, for a listing of BMPs and mitigation measures that FirstNet and/or their partners would require, as practicable or feasible, to help avoid or minimize potential impacts associated with land subsidence.

Potential Operation Impacts

As described in Section 2.1.2, Proposed Action Infrastructure, operation activities associated with the Preferred Alternative would consist of routine maintenance and inspection of the facilities. Any major infrastructure replacement as part of ongoing system maintenance would result in potential impacts similar to the abovementioned potential deployment impacts. It is anticipated that there would be *no impacts* at the programmatic level to geologic resources associated with routine inspections of the Preferred Alternative.

The operation of the Preferred Alternative could be affected by to geologic hazards including seismic activity, volcanic activity, landslides, and land subsidence. However, potential impacts would be anticipated to be *less than significant* at the programmatic level, and could be further reduced with implementation of the BMPs and mitigation measures discussed in Chapter 11, BMPs and Mitigation Measures.

8.2.3.5. *Alternatives Impact Assessment*

The following section assesses potential impacts to geologic resources associated with the Deployable Technologies Alternative and the No Action Alternative.[7]

Deployable Technologies Alternative

Under the Deployable Technologies Alternative option, a nationwide fleet of mobile land-based and aerial communications systems would provide temporary coverage in areas not covered by the existing, usable infrastructure. There would be no collocation of equipment and no new construction associated with wired or wireless projects discussed above under the Preferred Alternative. Some limited construction could be associated with implementation such as land clearing or paving for parking or staging areas. The specific infrastructure associated with the Deployable Technologies Alternative would be the same as the deployable technologies implemented as part of the Preferred Alternative but would likely be implemented in greater numbers, over a larger geographic extent, and used with greater frequency and duration. Potential impacts to geologic resources as a result of implementation of this alternative are described below.

Potential Deployment Impacts

As explained above, if deployment occurs on unpaved areas and/or if implementation results in paving of unpaved surfaces or if grading, excavation, or rock ripping is required for staging or launching/landing areas, implementation of deployable technologies (i.e., System on Wheels, Cell on Wheels, Cell on Light Truck, and Unmanned Aviation Vehicles) would likely result in *less than significant* impacts at the programmatic level to geologic resources. It is anticipated that the same BMPs and mitigation measures discussed for the Preferred Alternative would apply to the Deployable Technologies Alternative, to the extent practicable or feasible.

Potential Operation Impacts

As explained above, operation activities would consist of implementation/running of the deployable technology and routine maintenance and inspections. As with the Preferred Alternative, it is anticipated that there would be *no impacts* to geologic resources associated with routine inspections of the Deployable Technologies Alternative.

As with the Preferred Alternative, the operation of the Deployable Technologies Alternative could be affected due to geologic hazards including seismic activity, volcanic activity, landslides, and land subsidence. However, potential impacts would be anticipated to be *less than significant* at the programmatic level as deployable architecture is not fixed to the landscape and can be moved if necessary. It is anticipated that the same BMPs and mitigation measures discussed for the Preferred Alternative would apply to the Deployable Technologies Alternative, to the extent practicable or feasible.

[7] As mentioned above and in Section 2.1.2, Proposed Action Infrastructure, the Preferred Alternative includes implementation of deployable technologies.

No Action Alternative

Under the No Action Alternative, the NPSBN would not be deployed; therefore, there would be no associated construction or installation of wired, wireless, deployable infrastructure or satellites and other technologies. As a result, there would be *no impacts* to geologic resources because there would be no deployment or operation of the Proposed Action. Environmental conditions would therefore be the same as those described in Section 8.1.3, Geology.

8.2.4. Water Resources

8.2.4.1. Introduction

This section describes potential impacts to water resources in Puerto Rico associated with deployment and operation of the Proposed Action. Mitigation measures, as defined through permitting and/or consultation with the appropriate resource agency, would be implemented as part of deployment and operation of the Proposed Action to help avoid or reduce potential impacts to water resources. Implementation of best management practices (BMPs), as practicable or feasible, could further reduce the potential for impacts. Both mitigation measures and BMPs are discussed in Chapter 11, BMPs and Mitigation Measures.

8.2.4.2. Impact Assessment Methodology and Significance Criteria

The potential impacts of the Proposed Action on water resources were evaluated using the significance criteria presented in Table 8.2.4-1. As described in Section 8.2, Environmental Consequences, the categories of potential impacts are defined at the programmatic level as *potentially significant*, *less than significant with BMPs and mitigation measures incorporated*, *less than significant*, or *no impact*. Characteristics of each impact type, including magnitude or intensity, geographic extent, and duration or frequency, were used to determine the impact significance rating associated with each potential impact.

Given the nature of this programmatic evaluation, and because the Proposed Action could potentially cover a wide variety of actions that would take place in various landscapes, the potential impacts to water resources addressed in this section are presented as a range of possible impacts.

Table 8.2.4-1: Impact Significance Rating Criteria for Water Resources

Type of Effect	Effect Characteristics	Impact Level			
		Potentially Significant	**Less than Significant with BMPs and Mitigation Measures Incorporated**	**Less than Significant**	**No Impact**
Water Quality (groundwater and surface water) - sedimentation, pollutants, water temperature	Magnitude or Intensity	Groundwater contamination creating a drinking quality violation, or otherwise substantially degrade groundwater quality or aquifer; local construction sediment water quality violation, or otherwise substantially degrade water quality; water degradation poses a threat to the human environment,[a] biodiversity, or ecological integrity; violation of various regulations including: Clean Water Act, Safe Drinking Water Act	Effect that is *potentially significant*, but with BMPs and mitigation measures is *less than significant* at the programmatic level	Potential impacts to water quality, but potential effects to water quality would be below regulatory limits and would naturally balance back to baseline conditions	No changes to water quality, sedimentation, water temperature, or the presence of water pollutants
	Geographic Extent/Context	Watershed level, and/or within multiple watersheds		Watershed or subwatershed level[b]	NA
	Duration or Frequency	Chronic and long term changes not likely to be reversed over several years or seasons		The impact is temporary, lasting no more than 6 months	NA

Type of Effect	Effect Characteristics	Impact Level			
		Potentially Significant	**Less than Significant with BMPs and Mitigation Measures Incorporated**	**Less than Significant**	**No Impact**
Floodplain degradation*	Magnitude or Intensity	The use of floodplain fill, substantial increases in impervious surfaces, or placement of structures within a 500-year flood area that will impede or redirect flood flows or impact floodplain hydrology; high likelihood of encountering a 500-year floodplain within a state or territory	Effect that is *potentially significant*, but with BMPs and mitigation measures is *less than significant* at the programmatic level	Activities occur inside the 500-year floodplain, but do not use fill, do not substantially increase impervious surfaces or place structures that would impede or redirect flood flows or impact floodplain hydrology, and do not occur during flood events; there is a low likelihood of encountering a 500-year floodplain within a state or territory	Activities occur outside of floodplains and therefore do not increase fill or impervious surfaces, nor do they impact flood flows or hydrology within a floodplain
	Geographic Extent	Watershed level, and/or within multiple watersheds		Watershed or subwatershed level	NA
	Duration or Frequency	Chronic and long-term changes not likely to be reversed over several years or seasons		The impact is temporary, lasting no more than 1 season or water year, or occurring only during an emergency	NA
Drainage pattern alteration	Magnitude or Intensity	Alteration of the course of a stream of a river, including stream geomorphological conditions, or a substantial and measurable increase in the rate or amount of surface water or changes to the hydrologic regime	Effect that is *potentially significant*, but with BMPs and mitigation measures is *less than significant* at the programmatic level	Any alterations to the drainage pattern are minor and mimic natural processes or variations.	Activities do not impact drainage patterns
	Geographic Extent	Watershed level, and/or within multiple watersheds		Watershed or subwatershed level	NA
	Duration or Frequency	Impact occurs in perennial streams, and is ongoing and permanent		The impact is temporary, lasting no more than 6 months	NA

Type of Effect	Effect Characteristics	Impact Level			
		Potentially Significant	**Less than Significant with BMPs and Mitigation Measures Incorporated**	**Less than Significant**	**No Impact**
Flow alteration	Magnitude or Intensity	Consumptive use of surface water flows or diversion of surface water flows such that there is a measurable reduction in discharge	Effect that is *potentially significant*, but with BMPs and mitigation measures is *less than significant* at the programmatic level	Minor or no consumptive use with negligible impact on discharge	Activities do not impact discharge or stage of waterbody
	Geographic Extent	Watershed level, and/or within multiple watersheds		Watershed or subwatershed level	NA
	Duration or Frequency	Impact occurs in perennial streams, and is ongoing and permanent		Impact is temporary, not lasting more than 6 months	NA
Changes in groundwater or aquifer characteristics	Magnitude or Intensity	Substantial and measurable changes in groundwater or aquifer characteristics, including volume, timing, duration, and frequency of groundwater flow, and other changes to the groundwater hydrologic regime	Effect that is *potentially significant*, but with BMPs and mitigation measures is *less than significant* at the programmatic level	Any potential impacts to groundwater or aquifers are temporary, lasting no more than a few days, with no residual impacts	Activities do not impact groundwater or aquifers
	Geographic Extent	Watershed level, and/or within multiple watersheds		Watershed or subwatershed level	NA
	Duration or Frequency	Impact is ongoing and permanent		Potential impact is temporary, not lasting more than 6 months	NA

Note: Because public safety infrastructure is considered a critical facility, Proposed Action activities should avoid the 500-year floodplain wherever practicable per the Executive Orders on Floodplain Management (*Executive Orders 11988 and 13690*).
NA = not applicable
[a] The natural and the physical (e.g., structures) environment, and the association of people and their activities to those environments.
[b] Definitions of U.S. Geological Survey (USGS) watershed and subwatershed: USGS watershed refers to the USGS 10 digit hydrologic unit code (HUC10), which averages approximately 230 square miles, depending on the region. USGS subwatershed refers to the USGS 12 digit hydrologic unit code (HUC12), which averages approximately 40 square miles, depending on the region. See *USGS and NRCS 2014* for an explanation of HUC codes.

8.2.4.3. Description of Environmental Concerns

Water Quality – Potential Impacts Associated with Sedimentation, Pollutants, or Water Temperature

One of the primary environmental concerns during deployment activities is minimizing potential impacts to water quality. Potential impacts to water quality could result from sedimentation or pollutants, due to ground disturbance, disruption of streamside soils or vegetation, or spills of fluids from motorized equipment. Potential impacts to water quality due to deployment activities could be influenced by the timing of deployment, weather conditions, local topography, and the erosion and infiltration potential of soils.

Potential sedimentation impacts to streams or lakes, the near-shore ocean floor, or floodplains could be caused by ground disturbing construction activities such as trenching, pole installation, or road work.

Increased sedimentation in waterways could impair water and habitat quality and potentially affect aquatic plants and animals. Turbidity is the parameter for which surface water quality standards are most often not met in Puerto Rico (*PREQB 2014*). Potential impacts to water quality from erosion and sedimentation are most likely in areas where:

- Ground disturbance occurs in or near waterbodies or floodplains;
- Riparian vegetation is cleared or disturbed; and/or
- Steep slopes with moderate to severe erosion potential are disturbed (see Section 8.1.2, Soils, and Section 8.1.3, Geology).

Other potential sources of sedimentation impacts include vehicle travel on dirt or gravel roads, or off-road construction activity outside of the dry season. BMPs and mitigation measures would be implemented during deployment to adjust to local conditions and could help minimize soil erosion and storm water runoff.

During the dry season, the amount of sediment introduced to streams during vehicular travel, ground disturbance, or road work would be similar to natural erosion processes because there would be little or no flowing water on road surfaces or across disturbed areas.

Potential inputs of pollutants could occur if chemicals or petroleum products are spilled from equipment due to malfunction or refueling errors. Accidental spills of chemicals or petroleum products from motorized equipment during deployment could expose surface water resources to hazardous materials. Spills could also infiltrate the groundwater aquifer in areas with porous geology if they are not contained. Areas in Puerto Rico where groundwater is most likely vulnerable to these pollutants are in its alluvial valley aquifers (see the Groundwater Characteristics subsection of Section 8.1.4.3, Environmental Setting). Any spills from vehicles or machinery used during deployment tend to be associated with refueling activities, and as such, would likely be a few gallons or less in volume and could easily be contained and cleaned.

Most wood poles used for utility or telephone lines are treated with a preservative called pentachlorophenol (PCP) to lessen wood rot and extend the life of the poles. Once constructed, new treated poles could potentially impact surface water (or groundwater) by leaching PCP. Because of the demonstrated tendency for PCP to adhere to soils, the moderately rapid degradation of the compound in the environment, and the localized nature of the compound, it is unlikely that surface water (or groundwater) contamination would result from installation of the new wood poles. In addition, concentrations of PCP released during placement or replacement of poles are not expected to exceed United States (U.S.) Environmental Protection Agency (USEPA) levels of concern for human health.

In addition to sedimentation and pollutants, water temperature also plays a role in water quality and can influence the types of plants and animals (from fish to microorganisms) that reside in a particular waterbody. Water temperature could potentially be impacted by reduced stream shading in any areas where riparian vegetation is cleared.

To the extent practicable or feasible, FirstNet and/or their partners would work to avoid stream crossings. Given that most if not all streams in Puerto Rico are dry for a portion of the year, those crossings that are required could be limited to times when streams are dry or have minimal flow. If necessary to cross flowing streams, potential impacts could be reduced by scheduling stream crossings for times of the year when stream flow is lowest. Further, to the extent practicable or feasible, limiting deployment in areas with severe erosion potential due to sensitivity and constructability limitations associated with steep slopes could also reduce potential water quality impacts (see Section 8.1.2, Soils, and Section 8.1.3, Geology). However, because steep slopes are present throughout much of Puerto Rico, some limited amount of infrastructure could be built in these areas, in which case BMPs and mitigation measures (see Chapter 11, BMPs and Mitigation Measures) could help avoid or minimize the potential impacts. If appropriate BMPs and mitigation measures are implemented, soil erosion could be short-term and isolated within those locations with stability achieved after a few months or less.

Sedimentation, whether due to storm water runoff or other deployment activity, could return to current levels once construction is complete and once vegetation is reestablished in disturbed areas as a BMP. Additionally, creation of turbidity from installation of submarine infrastructure deployed in near-shore or inland bodies of water would be temporary and would likely return to background levels after deployment activities subside.

Floodplain Degradation

Floodplains can be degraded by construction of additional impervious surfaces or reduced ability to store floodwaters due to improper placement of fill material within the floodplain. Additionally, construction of structures in floodplains that cannot withstand flooding can cause residual effects for downstream areas where flood debris is transported. Soil compaction and removal of vegetation in the floodplain could contribute to erosion within the floodplain, lessen dissipation of water energy during floods, and impede floodplain permeability. In areas that are not permanently disturbed, these potential impacts could be reduced if these areas are restored by establishing new vegetation.

To the extent practicable or feasible, FirstNet and/or their partners would work to avoid deployment activities in floodplains, particularly in the floodway (e.g., the area including the channel and parts of the floodplain that convey and discharge typical floodwater levels). The employment of BMPs and mitigation measures as described in Chapter 11, BMPs and Mitigation Measures, could also help avoid or minimize potential impacts in floodplain areas.

Drainage Pattern Alteration

Drainage patterns could be altered if Proposed Action activities involved alteration of a stream or a river course. Alternations could occur due to changes in stream geomorphological conditions, and/or a substantial or measureable increase in the amount of surface water being conveyed or changes to the hydrologic regime of a surface waterbody. If in-stream construction activities such as trenching or road building were to involve rerouting of surface waters, drainage pattern alterations could occur. Surface disturbance associated with trenching and road building are not anticipated to occur at times when surface waters would need to be re-routed because most streams in Puerto Rico do not have perennial flow. Therefore, potential impacts to drainage patterns are unlikely. If construction activities would cross flowing streams (perennial streams or during times that intermittent streams have flow), potential impacts to drainage patterns could occur, although they would likely be temporary. BMPs and mitigation measures as described in Chapter 11, BMPs and Mitigation Measures, could help return streams to their natural course after construction is complete.

Flow Alteration

Stream flow could be altered if Proposed Action activities involved withdrawal of surface water or diversion of surface water flows such that there is a measurable reduction in stream discharge. Withdrawal of surface water (for water trucks used in dust suppression for air quality mitigation) would be unlikely to result in a significant quantity of water being withdrawn, and therefore would not be likely to impact to stream flow patterns.

Changes in Groundwater or Aquifer Characteristics

Groundwater or aquifer characteristics could be potentially impacted if Proposed Action activities involved contamination of groundwater with petroleum, lubricants, or other fluids from heavy equipment. As discussed above, any concentrations of PCP released to groundwater during placement or replacement of poles are not expected to exceed USEPA levels of concern for human health, and are likewise not anticipated to impact wildlife. Trenching for installation of Proposed Action features and pole placement could be deep enough to interact with shallow groundwater, but would not be expected to impact groundwater quality or aquifer characteristics, and any accidental spills of chemicals would likely be contained before they would reach groundwater. Therefore, impacts to groundwater are not anticipated.

8.2.4.4. Potential Impacts of the Preferred Alternative

The following section assesses potential impacts associated with implementation of the Preferred Alternative, including construction/deployment and operation activities.

Potential Deployment Impacts

As described in Section 2.1.2, Proposed Action Infrastructure, implementation of the Preferred Alternative could result in the deployment of various types of facilities or infrastructure. Depending on the physical nature and location of the facility/infrastructure and the specific deployment requirements, some activities could result in potential impacts to water resources and others would not. In addition, and as explained in this section, the various types of Preferred Alternative infrastructure could result in a range of *no impacts* to *less than significant* impacts at the programmatic level depending on the deployment scenario or site-specific conditions. Site-specific analysis may be required depending on the site conditions, the type of deployment, or any other permits or permissions necessary to perform the work.

Activities Likely to Have No Impacts

Of the types of facilities or infrastructure development scenarios described in Section 2.1.2, Proposed Action Infrastructure, the following are likely to have *no impacts* to water resources at the programmatic level under the conditions described below:

- Wired Projects
  - Use of Existing Conduit – New Buried Fiber Optic Plant: Disturbance associated with the installation of fiber optic cable in existing conduit would be limited to entry and exit points of the existing conduit in previously disturbed areas. It is anticipated that there would be *no impacts* to water resources at the programmatic level because the activities that would be conducted at these small entry and exit points are likely to be located in areas away from waterbodies, and are not likely to produce perceptible surface disturbances.
  - Use of Existing Buried or Aerial Fiber Optic Plant or Existing Submarine Cable: Lighting up of dark fiber would have *no impacts* to water resources because there would be no ground disturbance.
- Satellites and Other Technologies
  - Satellite-Enabled Devices and Equipment: It is anticipated that the installation of permanent equipment on existing structures and the use of portable devices that use satellite technology would not impact water resources because those activities would not require ground disturbance, construction in floodplains, or use of motorized equipment near streams.
  - Deployment of Satellites: FirstNet does not anticipate launching satellites as part of the deployment of the nationwide, public safety broadband network (NPSBN); however, it could include equipment on satellites that are already being launched for other purposes. As adding equipment to an existing launch vehicle would be very unlikely to impact water resources, it is anticipated that this activity would have *no impact* to those resources.

Activities with the Potential to Have Impacts

Potential construction/deployment-related impacts to water resources as a result of implementation of the Preferred Alternative would encompass a range of potential impacts that could occur as a result of ground disturbance activities, including in-stream construction work, resulting primarily in sediments entering streams, but also potentially to near-shore or inland waters, as well as the potential for other impacts to water quality and floodplains. The types of infrastructure development scenarios or deployment activities that could be part of the Preferred Alternative and result in potential impacts to water resources include the following:

- Wired Projects
  - New Build – Buried Fiber Optic Plant: Plowing (including vibratory plowing), trenching, or directional boring and the construction of points of presence (POPs),[1] huts, or other associated facilities or hand-holes to access fiber could result in potential impacts to water resources. Ground disturbance and heavy equipment use associated with plowing, trenching, or directional boring as well as land/vegetation clearing, excavation activities, and landscape grading associated with construction of POPs, huts, or other associated facilities or hand-holes to access fiber could result in stream sedimentation, construction of impervious surfaces and structures in floodplains, stream channel alteration, and accidental spills of fuels or lubricants to waterbodies. New Build – Buried Fiber Optic Plant projects could present a higher risk to water resources because of their relatively high degree of soil disturbance compared to the other types of projects.
  - New Build – Aerial Fiber Optic Plant: Soil exposure from installation of new poles or construction of new roads, POPs, huts, or other facilities near waterbodies could result in ground disturbance, potentially resulting in sediment deposition and increased turbidity in nearby waterbodies. The use of heavy equipment during the installation of new poles and cables could result in soil disturbance and the resulting potential sedimentation impacts to streams, disturbance of riparian vegetation, leaching of PCPs, and accidental spills of fuels or lubricants to waterbodies.
  - Collocation on Existing Aerial Fiber Optic Plant: Lighting up of dark fiber would have *no impacts* to water resources. If required, and if done in existing huts or on existing poles with no ground disturbance, installation of new associated equipment would have *no impacts* to water resources. Ground disturbance during the replacement of poles and structural hardening could result in soil erosion and sedimentation impacts to streams, particularly where this work would be done in proximity to waterbodies. Collocation on Existing Aerial Fiber Optic Plant projects could present a lower risk to water resources because of their relatively low degree of soil disturbance compared to the other types of projects.

[1] POPs are connections or access points between two different networks, or different components of one network.

  - New Build – Submarine Fiber Optic Plant: The installation of cables in near-shore or inland bodies of water could potentially impact water quality due to disruption of sediments on the floor of the waterbody. Impacts to water resources could also potentially occur as result of the construction of landings and/or facilities on shore to accept submarine cable. Sediments entering limited near-shore or inland waterbodies could potentially occur as result of grading, foundation excavation, or other ground disturbance activities. Construction of facilities in floodplains could potentially impact floodplain functionality and drainage patterns.
  - Installation of Optical Transmission or Centralized Transmission Equipment: If installation of transmission equipment would occur in existing boxes or huts and require no ground disturbance, there would be *no impacts* to water resources. If installation of transmission equipment required grading or other ground disturbance to install small boxes, huts, or access roads, there could potentially be impacts to water resources. The extent of these potential impacts would depend upon the proximity of the disturbance to waterbodies and floodplains and local conditions.
- Wireless Projects
  - New Wireless Communication Towers: Installation of new wireless towers and associated structures (generators, equipment sheds, fencing, security and aviation lighting, electrical feeds, and concrete foundations and pads) or access roads could result in potential impacts to water resources. Ground disturbance, vegetation clearing, excavation activities, and landscape grading associated with the installation of new wireless towers and associated structures or access roads could result in sediments entering streams and physical disturbance of streams if crossings are required. Additionally, use of heavy equipment around streams could result in the accidental spill of fuel or other liquids from equipment that could potentially impact water quality. New Wireless Communication Tower projects could present a higher risk to water resources than some of the lower risk wired projects because of their relatively high degree of soil disturbance compared to the other projects.
  - Collocation on Existing Wireless Tower, Structure, or Building: Collocation would involve mounting or installing equipment (such as antennas or microwave dishes) on an existing tower, which would not result in impacts to water resources because there would be no ground disturbance or in-water construction associated with this activity. The potential addition of power units, structural hardening, and physical security measures would not impact water resources if this activity would not require ground disturbance or in-water construction. However, if the on-site delivery of additional power units, structural hardening, and physical security measures required travel through streams or ground disturbance, such as grading or excavation activities near streams, potential impacts to water resources could occur including stream sedimentation and physical disturbance associated with heavy equipment use.

- Deployable Technologies
  - If deployable technologies would be implemented on existing paved surfaces, away from streams, and outside of floodplains, it is anticipated that there would be *no impacts* to water resources because there would be no ground disturbance or use of motorized equipment near streams. However, potential impacts could occur if deployment involves movement of equipment through streams, involves riparian or floodplain areas, or if the implementation results in minor construction, paving of previously unpaved surfaces in floodplains, or fuels leaking into the surface or groundwater. Some staging or landing areas (depending on the type of technology) could require land/vegetation clearing, excavation, and paving. These activities could result in erosion and sedimentation into streams. Heavy equipment use associated with these activities could result in stream sedimentation and physical disturbance of waterbodies if the equipment is used in or near streams. In addition, implementation of deployable technologies themselves could result in ground disturbance and related sediments entering waterbodies if they are deployed in unpaved areas near streams.

In general, the abovementioned activities could potentially involve land/vegetation clearing, ground disturbance, excavation, excavated material placement, trenching or directional boring, construction of access roads and other impervious surfaces, landscape grading, and heavy equipment movement. Potential impacts to water resources associated with deployment of this infrastructure, where in or near surface water, could include soil erosion and the resulting sediments entering waterbodies; construction of structures and impervious surfaces near waterbodies and in floodplains; in-water construction related to trenching, road building, and construction of marine infrastructure; and spills of fuels, lubricants, or other materials from construction and maintenance equipment to waterbodies. Associated BMPs and mitigation measures to help mitigate or reduce these potential impacts are described in Chapter 11, BMPs and Mitigation Measures.

Potential Water Quality Impacts

Based on the analysis of the deployment activities described above to water resources, potential impacts to water quality are anticipated to be *less than significant* at the programmatic level. See Chapter 11, BMPs and Mitigation Measures, for a listing of BMPs and mitigation measures that FirstNet and/or their partners would require, as practicable or feasible, to help avoid or minimize potential impacts to water resources.

Potential Floodplain Degradation Impacts

Based on the analysis of proposed activities described above, the development of Preferred Alternative facilities in floodplains could result in potentially *less than significant* impacts at the programmatic level (see Table 8.2.4-1). See Chapter 11, BMPs and Mitigation Measures, for a listing of BMPs and mitigation measures that FirstNet and/or their partners would require, as practicable or feasible, to help avoid or minimize potential impacts to water resources.

Potential Drainage Pattern Alteration Impacts

Based on the analysis of the proposed activities described above to water resources, potential impacts to water resources as a result of drainage pattern alteration are anticipated to be *less than significant* at the programmatic level. See Chapter 11, BMPs and Mitigation Measures, for a listing of BMPs and mitigation measures that FirstNet and/or their partners would require, as practicable or feasible, to help avoid or minimize potential impacts to water resources.

Potential Flow Alteration Impacts

Based on the analysis of the proposed activities described above, *no impacts* to water resources as a result of drainage pattern alteration would occur at the programmatic level as a result of the Preferred Alternative because activities would not impact the discharge or stage of waterbodies.

Potential Groundwater or Aquifer Impacts

Based on the analysis of the proposed activities described above, potential impacts to water resources as a result of groundwater or aquifer impacts are anticipated to be *less than significant* at the programmatic level. See Chapter 11, BMPs and Mitigation Measures, for a listing of BMPs and mitigation measures that FirstNet and/or their partners would require, as practicable or feasible, to help avoid or minimize potential impacts to water resources.

Potential Operation Impacts

As described in Section 2.1.2, Proposed Action Infrastructure, operation activities associated with the Preferred Alternative would consist of routine maintenance and inspection of the facilities. Any major infrastructure replacement as part of ongoing system maintenance would result in potential impacts similar to the abovementioned potential construction impacts. It is anticipated that there would be *no impacts* to water resources at the programmatic level associated with routine inspections of the Preferred Alternative, assuming that the same access roads used for deployment are also used for inspections. Vehicle refueling and maintenance activities are expected to produce *less than significant* impacts due to the limited volume of fluids contained in the equipment and the likelihood that such activities would occur offsite. Implementation of BMPs and mitigation measures could help further reduce potential impacts. If usage of heavy equipment as part of routine maintenance or inspections occurs off of established access roads or corridors and near waterbodies, the resulting ground disturbance could increase sedimentation in waterbodies, potentially impacting water quality. It is assumed that routine maintenance would not include operation of vehicles or equipment in waterbodies.

8.2.4.5. Alternatives Impact Assessment

The following section assesses potential impacts to water resources associated with the Deployable Technologies Alternative and the No Action Alternative.[2]

[2] As mentioned above and in Section 2.1.2, Proposed Action Infrastructure, the Preferred Alternative includes implementation of deployable technologies.

Deployable Technologies Alternative

Under the Deployable Technologies Alternative option, a nationwide fleet of mobile and aerial communications systems would provide temporary coverage in areas not covered by the existing, usable infrastructure. There would be no collocation of equipment and no new construction associated with wired or wireless projects discussed above under the Preferred Alternative. Some limited construction could be associated with implementation such as land clearing or paving for parking or staging areas. The specific infrastructure associated with the Deployable Technologies Alternative would be the same as the deployable technologies implemented as part of the Preferred Alternative but would likely be implemented in greater numbers, over a larger geographic extent, and used with greater frequency and duration. Therefore, potential impacts to water resources as a result of implementation of this alternative could be as described below.

Potential Deployment Impacts

As explained above, implementation of deployable technologies could result in *less than significant* impacts to water resources at the programmatic level if deployment of ground-based equipment occurs in unpaved areas, or if the implementation results in paving of previously unpaved surfaces. In addition, potential impacts to water resources could occur if equipment maintenance and refueling standards are not followed, resulting in spills of petroleum products or other chemicals to surface waters. Some staging or landing areas (depending on the type of technology) could require land/vegetation clearing, minor excavation, and paving. These activities could result in soil erosion and related sediments entering streams, drainage pattern alteration through the creation of cleared or impervious surfaces, and/or floodplain degradation if these activities occur in floodplains. Deployment and heavy equipment use associated with these activities could result in ground disturbance and sedimentation.

Potential Operation Impacts

As explained above, operation activities would consist of implementation and running of the deployable technology and routine maintenance and inspections. It is anticipated that there would be *no impacts* to water resources associated with routine inspections of the Deployable Technologies Alternative, assuming that the same access roads used for deployment are also used for inspections. If usage of heavy equipment as part of routine maintenance or inspections occurs off of established access roads or corridors and near waterbodies, the resulting ground disturbance could increase sedimentation in waterbodies, potentially impacting water quality. It is assumed that routine maintenance would not include operation of vehicles or equipment in waterbodies. Site maintenance, including mowing or herbicides, may result in *less than significant* effects to water quality at the programmatic level, depending on the location and amount of herbicides used. In addition, the presence of new access roads could increase the overall amount of impervious surface in the area, and increase runoff effects on water resources, as explained above. Finally, if ground-based deployable technologies are parked and operated with air conditioning for extended periods of time, the condensation water from the air conditioner could result in soil erosion that could potentially impact waterbodies if the deployables are located adjacent to waterbodies. It is anticipated that operation impacts on water quality would be *less than significant* at the programmatic level due to the small scale of expected FirstNet activities in any one location.

No Action Alternative

Under the No Action Alternative, the NPSBN would not be deployed; therefore there would be no associated construction or installation of wired, wireless, deployable infrastructure or satellites and other technologies. As a result, there would be *no impacts* to water resources because there would be no deployment or operation of the Proposed Action. Environmental conditions would therefore be the same as those described in Section 8.1.4, Water Resources.

8.2.5. Wetlands

8.2.5.1. Introduction

This section describes potential impacts to wetland resources in Puerto Rico associated with deployment and operation of the Proposed Action. Mitigation measures, as defined through permitting and/or consultation with the appropriate resource agency, would be implemented as part of deployment and operation of the Proposed Action to help avoid or reduce potential impacts to wetland resources. Implementation of best management practices (BMPs), as practicable or feasible, could further reduce the potential for impacts. Both mitigation measures and BMPs are discussed in Chapter 11, BMPs and Mitigation Measures.

8.2.5.2. Impact Assessment Methodology and Significance Criteria

The potential impacts of the Proposed Action on wetland resources were evaluated using the significance criteria presented in Table 8.2.5-1. As described in Section 8.2, Environmental Consequences, the categories of potential impacts are defined at the programmatic level as *potentially significant*, *less than significant with BMPs and mitigation measures incorporated*, *less than significant*, or *no impact*. Characteristics of each potential impact type, including magnitude or intensity, geographic extent, and duration or frequency, were used to determine the impact significance rating associated with each potential impact.

As discussed in Section 8.1.5, Wetlands, wetlands are recognized as important for maintenance of watershed and environmental health due to their potential to perform various ecological, hydrologic, biogeochemical, and social functions, although not all wetlands perform these functions equally. Typical wetland functions in Puerto Rico include shoreline and stream bank stabilization, flood mitigation, maintenance of water quality, maintenance of fish and wildlife habitat, sediment retention, groundwater discharge and recharge, and maintenance of nutrient retention and export. Their capacity or degree to which they perform individual functions depends on the wetland characteristics including soil type, substrate, type and percent cover of vegetation, water source, landscape position, location within a watershed, and location relative to populated areas (*USGS 1997*).

As part of mitigation planning (to avoid minimize, and/or compensate for unavoidable impacts to wetlands) associated with Clean Water Act (CWA) Section 404 permitting, a wetland functional assessment is typically used to categorize wetlands into one of three categories, as defined by the United States (U.S.) Army Corps of Engineers (USACE) (*USACE 2014*). Category 1 wetlands are the highest quality or functioning wetlands (or rare/unique); Category 2 wetlands are moderate to high functioning (or rare/unique); and Category 3 wetlands are lesser quality or lower functioning (or less rare/unique). Although these categories are useful for determining the significance of project-specific impacts to wetlands, given the programmatic nature of this environmental analysis, the magnitude of potential wetland impacts are discussed more broadly as part of the significance criteria presented in Table 8.2.5-1.

Table 8.2.5-1: Impact Significance Rating Criteria for Wetlands

Type of Effect	Effect Characteristics	Impact Level			
		Potentially Significant	Less than Significant with BMPs and Mitigation Measures Incorporated	Less than Significant	No Impact
Direct wetland loss (fill or conversion to non-wetland)	Magnitude[a] or Intensity	Substantial loss of high-quality wetlands (e.g., those that provide critical habitat for sensitive or listed species, are rare or a high-quality example of a wetland type, are not fragmented, support a wide variety of species, etc.); violations of Section 404 of the Clean Water Act	Effect that is *potentially significant*, but with mitigation is *less than significant* at the programmatic level	Impacts to lower quality wetlands (e.g., not rare or unique, that have low productivity and species diversity, and those that are already impaired or impacted by human activity)	No direct loss of wetlands
	Geographic Extent	USGS watershed level (e.g., HUC10)[b] and/or within multiple watersheds		USGS watershed (HUC10)[b] or subwatershed (HUC12)[b] level	NA
	Duration or Frequency	Long-term or permanent loss, degradation, or conversion to non-wetland		Periodic and/or temporary loss reversed over one to two growing seasons with or without active restoration	NA

Type of Effect	Effect Characteristics	Impact Level: Potentially Significant	Impact Level: Less than Significant with BMPs and Mitigation Measures Incorporated	Impact Level: Less than Significant	Impact Level: No Impact
Other direct effects: vegetation clearing; ground disturbance; direct hydrologic changes (flooding or draining); direct soil changes; water quality degradation (spills or sedimentation)	Magnitude or Intensity	Substantial and measurable changes to hydrological regime of high-quality wetlands impacting salinity, pollutants, nutrients, biodiversity (diversity of species present), ecological condition, or water quality; introduction and establishment of invasive plant or animal species to high-quality wetlands	Effect that is *potentially significant*, but with mitigation is *less than significant* at the programmatic level	Impacts to lower quality wetlands affecting the hydrological regime including salinity, pollutants, nutrients, biodiversity (diversity of species present), ecological condition, or water quality; Introduction and establishment of invasive plant or animal species to high-quality wetlands	No direct impacts to wetlands affecting vegetation, hydrology, soils, or water quality
	Geographic Extent	USGS watershed level (e.g., HUC10)[b] and/or within multiple watersheds		USGS watershed (HUC10)[b] or subwatershed (HUC12)[b] level	NA
	Duration or Frequency	Long-term or permanent alteration that is not restored within two growing seasons, or ever		Periodic and/or temporary loss reversed over one to two growing seasons with or without active restoration	NA

Type of Effect	Effect Characteristics	Impact Level			
		Potentially Significant	**Less than Significant with BMPs and Mitigation Measures Incorporated**	**Less than Significant**	**No Impact**
Indirect effects:[c] change in function(s);[d] change in wetland type	Magnitude or Intensity	Changes to the functions or type of high-quality wetlands (e.g., those that provide critical habitat for sensitive or listed species, are rare or a high-quality example of a wetland type, are not fragmented, support a wide variety of species, etc.)	Effect that is *potentially significant*, but with mitigation is *less than significant* at the programmatic level	Impacts to lower quality wetlands (e.g., not rare or unique, that have low productivity and species diversity, and those that are already impaired or impacted by human activity)	No changes in wetland function or type
	Geographic Extent	USGS watershed level (e.g., HUC10)[b] and/or within multiple watersheds		USGS watershed (HUC10)[b] or subwatershed (HUC12)[b] level	NA
	Duration or Frequency	Long-term or permanent change in function or type that is not restored within two growing seasons, or ever		Periodic and/or temporary loss reversed over one to two growing seasons with or without active restoration	NA

NA= not applicable
[a] Magnitude is defined based on the type of wetland impacted, high or low quality.
[b] Definitions of USGS watershed and subwatershed: *USGS Watershed* refers to the USGS 10 digit hydrologic unit code (HUC10), which averages approximately 230 square miles, depending on the region. *USGS Subwatershed* refers to the USGS 12 digit hydrologic unit code (HUC12), which averages approximately 40 square miles, depending on the region. See *USGS and NRCS (2013)* for an explanation of HUC codes.
[c] Indirect effects are those resulting from direct effects, but they occur elsewhere in space and/or time.
[d] Wetland functions include hydrologic, ecological, geomorphic, and social functions typically assessed for wetlands as part of USACE compensatory mitigation planning. Typical functions assessed may include flood attenuation, bank stabilization, water quality, organic matter input/transport, nutrient processing, wildlife habitat, threatened and endangered species habitat, biodiversity, recreational/social value.

Given the nature of this programmatic evaluation, and because the Proposed Action could potentially cover a wide variety of actions that would take place in various landscapes, the potential impacts to wetland resources addressed in this section are presented as a range of possible impacts.

8.2.5.3. Description of Environmental Concerns

Table 8.2.5-1 presents three types of potential effects to wetlands that were evaluated: direct wetland loss, other direct effects, and indirect effects. *Direct wetland loss* includes the actual loss of wetland habitat due to fill or conversion to a non-wetland habitat, such as a dryer habitat (upland area), or a wetter habitat (e.g., lake or stream). *Other direct effects* includes any direct effects that cause impacts such that the area remains a wetland and is not lost or converted, but the impacts cause a change in the type of wetland or a decrease in wetland function. *Indirect effects* are effects that occur secondarily as a result of direct effects and, like direct effects, cause a change in the type of wetland or a decrease in wetland function.

Wetland Loss

Wetland loss is a primary environmental concern for wetlands during construction. Direct wetland loss can be caused by the placement of fill into wetlands, thereby converting the wetland to a developed area. Wetlands can also be lost due to impacts to hydrology that cause a wetland to convert to a non-wetlands either by draining (converting a wetland to an upland area), or by inundation (converting a wetland to a waterbody such as a lake). Hydrologic changes can occur due to several activities, including draining or damming of a wetland, or placing fill outside of, but up or down flow of, the wetland's primary hydrologic source (in turn causing drying or inundation of the wetland, respectively); replacing native soil with soil having different drainage rates; compacting or rutting soil; or increasing non-permeable surfaces. All of these activities can in turn alter wetland drainage patterns. Potential impacts to soils that could indirectly cause changes to hydrology are discussed in greater detail in Section 8.2.2, Soils. Potential impacts to water resources that could directly or indirectly impact wetland hydrology are discussed in Section 8.2.4, Water Resources.

To the extent practicable or feasible, FirstNet and/or their partners would avoid filling wetlands or altering the hydrologic regime so that wetlands would not be lost or converted to non-wetlands. Loss of both high- and low-quality wetlands would be *less than significant* at the programmatic level given the small amount of land disturbance associated with the project locations (generally less than an acre) and the short time-frame of deployment activities. Additionally, site-specific analysis may be required depending on the site conditions, the type of deployment, or any other permits or permissions necessary to perform the work. Potential wetlands impacts could be further reduced by implementing BMPs and mitigation measures (see Chapter 11, BMPs and Mitigation Measures).

Other Direct Effects

For the purpose of this assessment, direct effects are defined as any effect that occurs in the same time and place as the impact, resulting from activities including vegetation clearing, ground disturbance, hydrologic alteration such as flooding or draining, changes to soils, or water quality degradation. Short of causing wetland loss, these construction and/or operation activities could potentially cause direct effects to wetlands, such as a change in the type of wetland (e.g., vegetation type), or a decrease or loss of one or all wetland functions performed by a given wetland. These activities can alter the wetland type by shifting vegetation structure, such as changing from a forested to a woody shrub or herbaceous vegetation type, due to vegetation clearing, or changes in hydrology or soil drainage. Some or all wetland functions in a given wetland can be lost or decreased due to the activities described above. Effects to both high- and low-quality wetlands would be *less than significant* at the programmatic level given the small amount of land disturbance associated with the project locations (generally less than an acre), the short timeframe of deployment activities, and the application of federal, Commonwealth, or locally required wetlands regulations. Additionally, site-specific analysis may be required depending on the site conditions, the type of deployment, or any other permits or permissions necessary to perform the work. Potential wetlands impacts could be further reduced by implementing BMPs and mitigation measures (see Chapter 11, BMPs and Mitigation Measures).

Indirect Effects

Indirect effects can result from the same activities that cause direct effects, but the effect occurs secondarily (e.g., in a different time or location) to the direct effects. In the same ways as direct effects, indirect effects can result in a change in wetland type or decrease in wetland function. In the case of wetlands, indirect effects can be the result of direct hydrologic alterations. For example, changes in hydrology caused by direct effects (e.g., fill placement) can result in a cascade of indirect effects, including changes in vegetation structure, changes in the type of wildlife habitat that is supported by the wetland, and changes to the functions that the wetland provides, including bank stability, filtering of pollutants for maintenance of water quality, and mitigation of flood flows. Indirect effects can also occur due to other activities such as vegetation clearing and ground disturbance, resulting in changes in wildlife habitat, weed infestation, and changes in wetland function, as described previously.

It is anticipated that indirect effects to both high- and low-quality wetlands would be *less than significant* at the programmatic level due to the small footprint of deployment activities (generally less than an acre), the short duration of those activities, and the application of federal, Commonwealth, or locally required wetlands regulations. Implementation of BMPs and mitigation measures (see Chapter 11) could further reduce these potential impacts. As with the direct effects category described above, the indirect effects category includes only effects that do not cause wetland loss or conversion to non-wetland, which are covered in the wetland loss category above.

8.2.5.4. Potential Impacts of the Preferred Alternative

Potential Deployment Impacts

As described in Section 2.1.2, Proposed Action Infrastructure, implementation of the Preferred Alternative could result in the deployment of various types of facilities or infrastructure. Depending on the physical nature and location of the facility/infrastructure and the specific deployment requirements, some activities could result in potential impacts to wetland resources. In addition, and as explained in this section, the various types of Preferred Alternative infrastructure could result in a range of *no impacts* to *less than significant* impacts at the programmatic level depending on the deployment scenario or site-specific conditions. Site-specific analysis may be required depending on the site conditions, the type of deployment, or any other permits or permissions necessary to perform the work.

Activities Likely to Have No Impacts

Of the types of facilities or infrastructure development scenarios described in Section 2.1.2, Proposed Action Infrastructure, the following are likely to have *no impacts* at the programmatic level to wetland resources under the conditions described below:[1]

- Wired Projects
  - Use of Existing Conduit – New Buried Fiber Optic Plant: Disturbance associated with the installation of fiber optic cable in existing conduit would be limited to entry and exit points of the existing conduit in previously disturbed areas. It is anticipated that there would be *no impacts* at the programmatic level to wetlands resources because the activities that would be conducted at these small entry and exit points are not likely to produce perceptible changes.
  - Use of Existing Buried or Aerial Fiber Optic Plant or Existing Submarine Cable: Lighting up of dark fiber would have *no impacts* to wetlands resources because there would be no ground disturbance.
- Satellites and Other Technologies
  - Satellite-Enabled Devices and Equipment: It is anticipated that the installation of permanent equipment on existing structures and the use of portable devices that use satellite technology would not impact wetland resources because those activities would not require ground disturbance.
  - Deployment of Satellites: FirstNet does not anticipate launching satellites as part of the deployment of the nationwide public safety broadband network (NPSBN); however, it could include equipment on satellites that are already being launched for other purposes. As adding equipment to an existing launch vehicle would not impact wetlands resources, it is anticipated that this activity would have no impact to those resources.

[1] A determination of *no impact* from these activities assumes that no heavy construction equipment would be required for deployment, or if heavy construction equipment were required, it would be deployed on a paved or non-paved gravel surface.

Activities with the Potential to Have Impacts

Potential deployment-related impacts to wetland resources as a result of implementation of the Preferred Alternative would encompass a range of potential impacts that could occur as a result of project construction activities. The following types of infrastructure development or deployment activities could cause wetland loss, conversion of wetlands to non-wetlands, or direct or indirect effects to wetlands as a result of wetland fill, vegetation clearing, landscape grading, soil compaction, and other various ground disturbance activities. Potential wetland impacts associated with each infrastructure development type are discussed below.

- Wired Projects
  - New Build – Buried Fiber Optic Plant: Plowing, trenching, or directional boring and the construction of points of presence,[2] huts, or other associated facilities or hand-holes to access fiber could result in potential impacts to wetlands from both construction equipment and the activity itself.
  - New Build – Aerial Fiber Optic Plant: Topsoil removal, soil excavation, and excavated material placement during the installation of new poles could result in wetland loss, conversion, or direct or indirect effects. The use of heavy equipment during the installation of new poles and hanging of cables could result in direct or indirect effects to wetlands.
  - Collocation on Existing Aerial Fiber Optic Plant: Topsoil removal, soil excavation, and excavated material placement during the replacement of poles and structural hardening could result in wetland fill, conversion, or direct or indirect effects to wetlands.
  - New Build – Submarine Fiber Optic Plant: The installation of cables in limited near-shore or inland bodies of water could potentially impact wetland resources if the water body was a flooded wetland. In addition, potential wetland impacts could occur as a result of the construction of landings and/or facilities on shore to accept submarine cable.
  - Installation of Optical Transmission or Centralized Transmission Equipment: If installation of transmission equipment would occur in existing boxes or huts and require no ground disturbance, there would be *no impacts* to wetlands. However, if installation of transmission equipment required vegetation clearing, grading, or other ground disturbance to install small boxes, huts, or access roads, wetland loss, conversion, or direct or indirect effects to wetlands could potentially occur.
- Wireless Projects
  - New Wireless Communication Towers: Installation of new wireless towers and associated structures (generators, equipment sheds, fencing, security and aviation lighting, electrical feeds, and concrete foundations and pads) or access roads could result in potential impacts to wetland resources. Land/vegetation clearing, excavation activities, landscape grading, and other ground disturbance activities during the

[2] Points of presence are connections or access points between two different networks, or different components of one network.

installation of new wireless towers and associated structures or access roads could result in wetland loss, conversion, or direct or indirect effects to wetlands.

 - Collocation on Existing Wireless Tower, Structure, or Building: Collocation would involve mounting or installing equipment (such as antennas or microwave dishes) on an existing tower or structure, which would have *no impacts* to wetlands because there would be no ground disturbance associated with this activity. The potential addition of power units, structural hardening, and physical security measures would also have *no impacts* on wetland resources if this activity would not require ground disturbance. However, if the onsite delivery of additional power units, structural hardening, and physical security measures required ground disturbance, such as grading or excavation activities, direct or indirect effects to wetlands could occur.

- Deployable Technologies
  - Implementation of deployable aerial communications architecture (such as drones, balloons, or piloted aircraft) would not likely result in any potential impacts to wetlands, as there would not be any ground disturbance. Implementation of ground-based Cell on Wheels, Cell on Light Truck, and System on Wheels would not result in potential impacts to wetland resources if deployment occurs on paved or non-paved gravel surfaces. However, implementation of the three land-based deployable technologies (Cell on Wheels, Cell on Light Truck, and System on Wheels) could result in potential impacts to wetland resources if deployment occurs in undeveloped areas requiring minor construction, grading, filling, or paving of a surface to place a deployable technology. Some staging or landing areas (depending on the type of technology) could require land/vegetation clearing, excavation, and paving.

Potential Wetland Impacts

Based on the analysis of the deployment activities described above to wetland resources, potential impacts as a result of Preferred Alternative activities are anticipated to be *less than significant* at the programmatic level given the small amount of land disturbance associated with the project locations (generally less than an acre) and the short time-frame of deployment activities.

Wetlands comprise just over 5 percent of the area in Puerto Rico, and are therefore considered a rare, highly valued habitat type to be preserved. In addition to their general uniqueness, most Puerto Rican wetlands are considered high-quality areas due to their provision of one or more important hydrologic, geomorphic, ecological, or social functions (*PRDNER 2010; USGS 1996*). Functions specific to Puerto Rican wetlands include maintenance of groundwater quality to protect drinking water resources; maintenance of surface water quality; coastal or inland waterbody bank stabilization; habitat for endemic,[3] threatened, endangered, or other species of concern; high-quality general wildlife habitat; community water storage, flood mitigation, and/or coastal storm protection; fish and shellfish habitat (*PRDNER 2010; USGS 1996*).

[3] Endemic species are only found in one area or region.

The Draft Puerto Rico Coastal and Estuarine Land Conservation Plan, developed by the Puerto Rico Department of Natural and Environmental Resources (*PRDNER 2010*), identifies wetland habitats as one of the "principal habitats of concern" for their "contribution to the ecological integrity of the overall coastal environment…." However, loss of wetlands or direct or indirect potential impacts resulting in a decrease in any wetland functions would be *less than significant* at the programmatic level given the small amount of land disturbance associated with the project locations (generally less than an acre) and the short timeframe of deployment activities.

Additionally, site-specific analysis may be required depending on the site conditions, the type of deployment, or any other permits or permissions necessary to perform the work. Potential wetlands impacts could be further reduced by implementing BMPs and mitigation measures (see Chapter 11, BMPs and Mitigation Measures).

In addition to a low relative abundance of wetlands in general, certain wetland types are also regionally rare or unique (such as freshwater ponds, estuarine emergent wetlands [marshes], and marine intertidal wetlands [*USGS 1996; USFWS 2015*]), and would be considered high quality based on this characteristic alone. One example of a rare and unique wetland type in Puerto Rico is the bloodwood forest, estuarine or palustrine forests that are now rare in Puerto Rico (*USGS 1996*). In the high mountains, the cloud forest, Colorado forest, and palm forest are also important wetland types, and the Cabo Rojo salt flats located on the southwestern coast are important migratory bird habitat. The Laguna Tortuguero is hydrologically unique as the island's only marsh that is fed by seeps and springs (*USGS 1996*).

Relative abundance of wetland types on Puerto Rico are presented in Section, 8.1.5.4, Wetland Characteristics. Other characteristics and/or wetland types other than those listed here can certainly be associated with high-quality wetlands. The Department of Environmental and Natural Resources, U.S. Fish and Wildlife Service, and U.S. Environmental Protection Agency have prepared prioritized lists of important wetland resource areas on Puerto Rico that should also be consulted prior to locating deployment activities (*USGS 1996*). As described in Section 8.2.5.2, Impact Assessment Methodology and Significance Criteria, the quality or uniqueness of wetlands potentially impacted by deployment activities would require a formal assessment on a case by case basis as part of Proposed Action permitting.

To minimize potential impacts to wetlands, BMPs and mitigation measures would be implemented in compliance with any issued federal, Commonwealth, and local permits. For example, loss of jurisdictional wetlands[4] resulting from the placement of dredged or fill material would require a CWA Section 404 permit, issued by the USACE and reviewed by the U.S. Environmental Protection Agency. See Chapter 11, BMPs and Mitigation Measures, for a listing of BMPs and mitigation measures that FirstNet and/or their partners would require, as practicable or feasible, to help avoid or minimize potential impacts associated with wetlands.

[4] Jurisdictional wetlands are wetlands that are found to be "waters of the U.S." per definitions presented in the CWA, and are thus under the jurisdiction of the USACE.

Potential Operation Impacts

As described in Section 2.1.2, Proposed Action Infrastructure, operation activities associated with the Preferred Alternative would consist of routine maintenance and inspection of the facilities. Any major infrastructure replacement as part of ongoing system maintenance would result in potential impacts similar to the abovementioned potential deployment impacts. It is anticipated that there would be *no impacts* at the programmatic level to wetland resources associated with routine inspections of the Preferred Alternative, assuming that the same access roads used for deployment are also used for inspections, and assuming that all federal, Commonwealth, and local requirements associated with refueling and vehicle maintenance are followed. Even if heavy equipment is used as part of routine maintenance, inspections occur off of established access roads or corridors, or routine maintenance and application of herbicides is used to control vegetation, potential wetland impacts could be *less than significant* at the programmatic level as explained above.

8.2.5.5. Alternatives Impact Assessment

The following section assesses potential impacts to wetlands associated with the Deployable Technologies Alternative and the No Action Alternative.[5]

Deployable Technologies Alternative

Under the Deployable Technologies Alternative, a nationwide fleet of aerial and land-based mobile communications systems would provide temporary coverage in areas not covered by the existing, usable infrastructure. There would be no collocation of equipment and no new construction associated with wired or wireless projects discussed above under the Preferred Alternative. Some limited construction could be associated with implementation such as land clearing or paving for parking or staging areas. The specific infrastructure associated with the Deployable Technologies Alternative would be the same as the deployable technologies implemented as part of the Preferred Alternative but would likely be implemented in greater numbers, over a larger geographic extent, and used with greater frequency and duration. Therefore, potential impacts to wetland resources as a result of implementation of this alternative could be as described below.

Potential Deployment Impacts

Implementation of the three land-based deployable technologies (Cell on Wheels, Cell on Light Truck, and System on Wheels) could result in *less than significant* impacts at the programmatic level. Some staging or landing areas (depending on the type of technology) may require land/vegetation clearing, excavation, and paving. These activities could result in wetland loss, conversion, or direct or indirect effects to wetlands. Heavy equipment use associated with these activities could result in soil compaction, resulting in direct or indirect potential impacts to wetlands. However, it is anticipated that impacts to wetlands would be *less than significant* at the programmatic level due to the small footprint of deployment activities (generally less than an

[5] As mentioned above and in Section 2.1.2, Proposed Action Infrastructure, the Preferred Alternative includes implementation of deployable technologies.

acre), the short duration of those activities, and the application of federal, Commonwealth, or locally required wetlands regulations. Implementation of BMPs and mitigation measures (see Chapter 11) could further reduce these potential impacts.

Potential Operation Impacts

As explained above, operation activities would consist of implementation/running of the deployable technology and routine maintenance and inspections. As with the Preferred Alternative, it is anticipated that there would be *no impacts* at the programmatic level to wetland resources associated with routine inspections and maintenance of the Deployable Technologies Alternative, assuming the use of access roads and compliance with refueling and vehicle maintenance requirements, and *less than significant* potential impacts at the programmatic level associated with maintenance activities even if heavy equipment is used as part of routine maintenance, inspections occur off of established access roads or corridors, or routine maintenance and application of herbicides is used to control vegetation.

No Action Alternative

Under the No Action Alternative, the NPSBN would not be deployed; therefore, there would be no associated construction or installation of wired, wireless, deployable infrastructure or satellites and other technologies. As a result, there would be *no impacts* to wetland resources because there would be no construction or operation of the Proposed Action. Environmental conditions would therefore be the same as those described in Section 8.1.5, Wetlands.

8.2.6. Biological Resources

8.2.6.1. Introduction

This section describes potential impacts to biological resources in Puerto Rico associated with deployment and operation of the Proposed Action. As discussed throughout the sections that follow, mitigation measures, as defined through permitting and/or consultation with the appropriate resource agency, would be implemented as part of deployment and operation of the Proposed Action to help avoid or reduce potential impacts biological resources. Implementation of best management practices (BMPs), as practicable or feasible, could further reduce the potential for impacts. Both mitigation measures and BMPs are discussed in Chapter 11, BMPs and Mitigation Measures.

The following resources are covered in this section:

- Terrestrial vegetation, including vegetation loss, fragmentation, and invasive species (Section 8.2.6.3, Terrestrial Vegetation);
- Wildlife, including amphibians and reptiles, terrestrial mammals, marine mammals, birds, and terrestrial invertebrates occurring in both onshore and offshore environments (Section 8.2.6.4, Wildlife);
- Fisheries and aquatic habitats, including both marine and freshwater species and habitats (Section 8.2.6.5, Fisheries and Aquatic Habitats); and
- Threatened and endangered species and species of conservation concern, including federal-, state-, or agency-listed plant and animal species and designated critical habitat (Section 8.2.6.6, Threatened and Endangered Species and Species of Conservation Concern).

8.2.6.2. Impact Assessment Methodology and Significance Criteria

The potential impacts of the Proposed Action on terrestrial vegetation, wildlife, and fisheries and aquatic habitats were evaluated using the significance criteria presented in Table 8.2.6.2-1 for direct injury/mortality; vegetation and habitat loss, alteration, or fragmentation; indirect injury/mortality; adverse effects to migration or migratory patterns; adverse reproductive effects; and invasive species effects. Additionally, the potential impacts of radio frequency emissions on birds, bats, and vegetation are covered in Section 8.2.6.4, Wildlife, and Section 8.2.6.3, Terrestrial Vegetation. As described in Section 8.2, Environmental Consequences, the categories of impacts at the programmatic level are defined as *potentially significant*, *less than significant with BMPs and mitigation measures incorporated*, *less than significant*, or *no impact*.

The potential impacts of the Proposed Action on threatened and endangered species and species of conservation concern were evaluated using the significance criteria presented in Table 8.2.6.6-1 in Section 8.2.6.6, Threatened and Endangered Species and Species of Conservation Concern. The categories of impacts at the programmatic level are defined as: *may affect, likely to adversely affect; may affect, not likely to adversely affect;* and *no effect*. These impact categories are comparable to those defined in the *Endangered Species Consultation Handbook* (*USFWS and NMFS 1998*).

Characteristics of each impact type, including magnitude or intensity, geographic extent, and duration or frequency, were used to determine the impact significance rating associated with each potential impact. Given the nature of this programmatic evaluation, and because the Proposed Action could potentially cover a wide variety of actions that would take place in various landscapes, the potential impacts to biological resources addressed in this section are presented as a range of possible impacts. Site-specific analysis may be required depending on the site conditions, the type of deployment, or any other permits or permissions necessary to perform the work.

Table 8.2.6.2-1: Impact Significance Rating Criteria for Terrestrial Vegetation, Wildlife, and Fisheries and Aquatic Habitats

Type of Effect	Effect Characteristics	Impact Level			
		Potentially Significant	**Less than Significant with BMPs and Mitigation Measures Incorporated**	**Less than Significant**	**No Impact**
Direct Injury/Mortality	Magnitude or Intensity	Population-level or sub-population[a] injury/mortality effects observed for at least one species depending on the distribution and the management of said species; events that may impact endemics[b] or concentrations during breeding or migratory periods; violation of various regulations including: MMPA, MBTA, and BGEPA	Effect that is *potentially significant*, but with BMPs and mitigation measures is *less than significant* at the programmatic level	Individual mortality observed but not sufficient to affect population or sub-population survival	No direct individual injury or mortality would be observed
	Geographic Extent	Adverse regional effects observed within each respective state or territory for at least one species. Anthropogenic[c] disturbances that lead to exclusion from nutritional or habitat resources, or direct injury or mortality of endemics or a significant portion of the population or sub-population located in a small area during a specific season		Effects realized at one location when population is widely distributed and not concentrated in affected area	NA
	Duration or Frequency	Chronic and long-term adverse effects not likely to be reversed over several years for at least one species		Temporary, isolated, or short-term effects that are reversed within 1 to 3 years	NA

Type of Effect	Effect Characteristics	Impact Level			
		Potentially Significant	**Less than Significant with BMPs and Mitigation Measures Incorporated**	**Less than Significant**	**No Impact**
Vegetation and Habitat Loss, Alteration, or Fragmentation	Magnitude or Intensity	Population-level or sub-population adverse effects observed for at least one species or vegetation cover type, depending on the distribution and the management of said species; impacts to terrestrial, aquatic, or riparian habitat or other sensitive natural community vital for feeding, spawning/breeding, foraging, migratory rest stops, refugia,[d] or cover from weather or predators; violation of various regulations including: MMPA, MBTA, and BGEPA	Effect that is *potentially significant*, but with BMPs and mitigation is *less than significant* at the programmatic level	Habitat alteration in locations not designated as vital or critical for any period; temporary losses to individual plants within cover types, or small habitat alterations take place in important habitat that is widely distributed and there are no cover type losses or cumulative effects from additional projects	Sufficient habitat would remain functional to maintain viability of all species. No damage or loss of terrestrial, aquatic, or riparian habitat from the Proposed Action would occur.
	Geographic Extent	Regional adverse effects observed within each respective state or territory for at least one species; anthropogenic disturbances that lead to the loss or alteration of nutritional or habitat resources for endemics or a significant portion of the population or subpopulation located in a small area during a specific season		Effects realized at one location	NA
	Duration or Frequency	Chronic and long-term adverse effects not likely to be reversed over several years for at least one species		Temporary, isolated, or short-term effects that are reversed within 1 to 3 years	NA

Type of Effect	Effect Characteristics	Impact Level			
		Potentially Significant	**Less than Significant with BMPs and Mitigation Measures Incorporated**	**Less than Significant**	**No Impact**
Indirect Injury/Mortality	Magnitude or Intensity	Population-level or sub-population adverse effects observed for at least one species depending on the distribution and the management of said species; exclusion from resources necessary for the survival of one or more species and one or more life stages; anthropogenic disturbances that lead to mortality, disorientation, or the avoidance or exclusion from nutritional or habitat resources for endemics or a significant portion of the population or sub-population located in a small area during a specific season; violation of various regulations including: MMPA, MBTA, and BGEPA	Effect that is *potentially significant*, but with BMPs and mitigation is *less than significant* at the programmatic level	Individual injury/mortality observed but not sufficient to affect population or sub-population survival; partial exclusion from resources in locations not designated as vital or critical for any given species or life stage, or exclusion from resources that takes place in important habitat that is widely distributed; anthropogenic disturbances are measurable but minimal as determined by individual behavior and propagation, and the potential for habituation or adaptability is high given time	No stress or avoidance of feeding or important habitat areas; no reduced population resulting from habitat abandonment
	Geographic Extent	Regional or site-specific adverse effects observed within each respective state or territory for at least one species; behavioral reactions to anthropogenic disturbances depend on the context, the time of year, age, previous experience, and activity; anthropogenic disturbances that lead to startle responses of large groupings of individuals during haulout[e] periods, resulting in injury or mortality		Effects realized at one location	NA
	Duration or Frequency	Chronic and long-term adverse effects not likely to be reversed over several years for at least one species		Temporary, isolated, or short-term effects that are reversed within 1 to 3 years	NA

Type of Effect	Effect Characteristics	Impact Level			
		Potentially Significant	**Less than Significant with BMPs and Mitigation Measures Incorporated**	**Less than Significant**	**No Impact**
Effects to Migration or Migratory Patterns	Magnitude or Intensity	Population-level or sub-population adverse effects observed for at least one species depending on the distribution and the management of said species; temporary or long-term loss of migratory pattern/path or rest stops due to anthropogenic activities; violation of various regulations including: MMPA, MBTA, and BGEPA	Effect that is *potentially significant*, but with BMPs and mitigation is *less than significant* at the programmatic level	Temporary loss of migratory rest stops due to anthropogenic activities takes place in important habitat that is widely distributed, and there are no cumulative effects from additional projects	No alteration of migratory pathways and no stress or avoidance of migratory paths/patterns due to Proposed Action activities
	Geographic Extent	Regional adverse effects observed within each respective state or territory for at least one species; anthropogenic disturbances that lead to exclusion from nutritional or habitat resources during migration, or lead to adverse changes of migratory routes for endemics or a significant portion of the population or sub-population located in a small area during a specific season		Effects realized at one location when population is widely distributed, and not concentrated in affected area	NA
	Duration or Frequency	Chronic and long-term adverse effects not likely to be reversed over several years for at least one species		Temporary, isolated, or short-term effects that are reversed within 1 to 3 years	NA

Type of Effect	Effect Characteristics	Impact Level			
		Potentially Significant	**Less than Significant with BMPs and Mitigation Measures Incorporated**	**Less than Significant**	**No Impact**
Reproductive Effects	Magnitude or Intensity	Population or sub-population level adverse effects in reproduction and productivity over several breeding/spawning seasons for at least one species depending on the distribution and the management of said species; violation of various regulations including: MMPA, MBTA, and BGEPA	Effect that is *potentially significant*, but with BMPs and mitigation is *less than significant* at the programmatic level	Effects to productivity are at the individual rather than population level; effects are within annual variances and not sufficient to affect population or sub-population survival	No reduced breeding or spawning success
	Geographic Extent	Regional adverse effects observed within each respective state or territory for at least one species; anthropogenic disturbances that lead to exclusion from prey or habitat resources required for breeding/spawning, or anthropogenic disturbances that lead to stress, abandonment, and loss of productivity for endemics or a significant portion of the population or sub-population located in a small area during the breeding/spawning season		Effects realized at one location	NA
	Duration or Frequency	Chronic and long-term adverse effects not likely to be reversed over several breeding/spawning seasons for at least one species		Temporary, isolated, or short-term effects that are reversed within one breeding season	NA

Type of Effect	**Effect Characteristics**	**Impact Level**			
		Potentially Significant	**Less than Significant with BMPs and Mitigation Measures Incorporated**	**Less than Significant**	**No Impact**
Invasive Species Effects	Magnitude or Intensity	Extensive increase in invasive species populations over several seasons	Effect that is *potentially significant*, but with BMPs and mitigation is *less than significant* at the programmatic level	Mortality observed in individual native species with no measurable increase in invasive species populations	No loss of forage and cover due to the invasion of exotic or invasive plants introduced to Proposed Action sites from machinery or human activity
	Geographic Extent	Regional impacts observed throughout the state or territory		Effects realized at one location	NA
	Duration or Frequency	Chronic and long-term adverse changes not likely to be reversed over several years or seasons		Periodic, temporary, or short-term changes that are reversed over one or two seasons	NA

BGEPA = Bald and Golden Eagle Protection Act; BMPs = best management practices; MBTA = Migratory Bird Treaty Act; MMPA = Marine Mammal Protection Act; NA = not applicable; RF = Radio Frequency

[a] A population consists of interbreeding organisms occupying a certain space; the number of people or other living creatures in a designated area.

[b] Endemics are species that are only found in one area or region.

[c] Anthropogenic means changes caused by humans.

[d] A refugia is an area of stable environmental conditions that protects wildlife and organisms from environmental change.

[e] Haulouts are areas of land or ice where seals and walrus come ashore to rest, molt, or breed.

8.2.6.3. Terrestrial Vegetation

Introduction

This section describes potential impacts to terrestrial vegetation resources in Puerto Rico associated with deployment and operation of the Proposed Action. Mitigation measures, as defined through permitting and/or consultation with the appropriate resource agency, would be implemented as part of deployment and operation of the Proposed Action to help avoid or reduce potential impacts to terrestrial vegetation resources. Implementation of best management practices (BMPs), as practicable or feasible, could further reduce the potential for impacts. Both mitigation measures and BMPs are discussed in Chapter 11, BMPs and Mitigation Measures.

Impact Assessment Methodology and Significance Criteria

The potential impacts of the Proposed Action on terrestrial vegetation resources were evaluated using the significance criteria presented in Table 8.2.6.2-1 for vegetation and habitat loss, alteration, or fragmentation, and invasive species effects.[1] As described in Section 8.2, Environmental Consequences, the categories of potential impacts are defined at the programmatic level as *potentially significant, less than significant with BMPs and mitigation measures incorporated, less than significant*, or *no impact*. Characteristics of each impact type, including magnitude or intensity, geographic extent, and duration or frequency, were used to determine the impact significance rating associated with each potential impact.

Given the nature of this programmatic evaluation, and because the Proposed Action could potentially cover a wide variety of actions that would take place in various landscapes, the potential impacts to terrestrial vegetation resources addressed in this section are presented as a range of possible impacts.

Description of Environmental Concerns

Terms and concepts discussed in this section are further discussed and defined in the Affected Environment section (Section 8.1.6.3, Terrestrial Vegetation).

Vegetation and Habitat Loss, Alteration, or Fragmentation[2]

With any construction project requiring ground disturbance, one of the main concerns during construction activities includes vegetation clearing. Not only could vegetation loss potentially result in wildlife habitat loss or fragmentation, as described in Section 8.2.6.4, Wildlife, it could also lead to accelerated erosion and increased sedimentation in waterways.[3] As explained in Section 8.2.2, Soils, soil erosion could alter natural sediment transport processes in streams and

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[1] Although direct and indirect injury/mortality, effects to migration or migratory patterns, and reproductive effects are types of effects presented in Table 8.2.6.2-1 that are applicable to other biological resources, these effects do not apply to terrestrial vegetation and are therefore not included in this section. For discussions of Wildlife, Fisheries and Aquatic Habitats, and Threatened and Endangered Species and Species of Conservation Concern, see Sections 8.2.6.4, 8.2.6.5, and 8.2.6.6, respectively. A discussion of potential wetland impacts is included in Section 8.2.5, Wetlands.

[2] Vegetation and habitat loss, alteration, or fragmentation effects related to wildlife are presented in Section 8.2.6.4, Wildlife.

[3] Keeping soil vegetated is often the most effective way to prevent erosion.

other surface waterbodies, which could impair water and habitat quality and potentially affect aquatic plants and animals. Soil suborders in Puerto Rico that have moderate to severe erosion potential include the Udalfs, Psamments, Udepts, Rendolls, Ustolls, Udox, Humults, and Udults soil suborders (see Section 8.2.2, Soils, for descriptions of these soil types).

As described and shown graphically in Section 8.1.6.3, Terrestrial Vegetation, the majority of Puerto Rico is covered by woody vegetation. Potential impacts to terrestrial vegetation could occur in areas where construction activities require vegetation cutting, clearing, and/or removal. It is anticipated that for most types of facilities or infrastructure development scenarios, vegetation loss would likely be isolated within construction locations and/or would be short-term with stability achieved within several years, depending on the vegetation cover present in the area.[4] As discussed in Chapter 11, BMPs and mitigation measures could help avoid or minimize potential vegetation loss associated with ground disturbance activities.

Some comments on other regional Draft PEIS documents for the Proposed Action expressed concerns related to the potential impacts to vegetation from radio frequency (RF) emissions. Although the comments were not submitted as part of the public comment period for the non-contiguous region, FirstNet believed the comments were overarching and should be addressed in all regions (rather than just the region that received the comments). Some studies have indicated the potential for adverse effects to vegetation from RF emissions. As explained in Section 2.4, Radio Frequency Emissions, as well as Section 8.2.6.4, Wildlife, additional, targeted research needs to be conducted to more fully document the nature and effects of RF exposure, including the potential impacts to vegetation.

Invasive Species Effects

Once a landscape has been cleared of vegetative cover and soil is disturbed, the re-establishment of native vegetation could be delayed or prevented if undesirable noxious weeds and/or invasive plants become established (*USFS Undated*). As discussed in Section 8.1.6.3, Terrestrial Vegetation, some invasive plants in Puerto Rico, such as the centipede tongavine (*Epipremnum pinnatum*), African evergreen (*Syngonium podphyllum*), and others, thrive in disturbed soil environments (*Global Invasive Species Database Undated*). Once established, these invasive plants could displace native plants preferred by native animals. In addition, construction equipment or vehicles traveling from areas infested with invasive or noxious plants to areas free of those plants could disperse them if proper care is not taken. BMPs and mitigation measures could help minimize these impacts (see Chapter 11, BMPs and Mitigation Measures).

[4] Clearing trees in forested and woodland areas (see Section 8.1.6.3, Terrestrial Vegetation, for an explanation of these vegetation types) could result in potential longer-term impacts given the length of time needed for these vegetation communities to mature to pre-disturbance conditions. Therefore, the duration of the potential impact would depend in part on the type of vegetation to be cleared. Grasses, for example, take less time to mature and become re-established than a stand of large trees.

Potential Impacts of the Preferred Alternative

The following section assesses potential impacts associated with implementation of the Preferred Alternative, including deployment and operation activities.

Potential Deployment Impacts

As described in Section 2.1.2, Proposed Action Infrastructure, implementation of the Preferred Alternative could result in the deployment of various types of facilities or infrastructure. Depending on the physical nature and location of the facility/infrastructure and the specific deployment requirements, some activities could result in potential impacts to terrestrial vegetation resources and others would not. In addition, and as explained in this section, various types of Preferred Alternative infrastructure could result in a range of *no impact* to *less than significant* impacts at the programmatic level depending on the deployment scenario or site-specific conditions. Site-specific analysis may be required depending on the site conditions, the type of deployment, or any other permits or permissions necessary to perform the work.

<u>Activities Likely to Have No Impacts</u>

Of the types of facilities or infrastructure development scenarios described in Section 2.1.2, Proposed Action Infrastructure, the following are likely to have *no impacts* to terrestrial vegetation resources at the programmatic level under the conditions described below:

- Wired Projects
  - Use of Existing Conduit–New Buried Fiber Optic Plant: Disturbance associated with the installation of fiber optic cable in existing conduit would be limited to entry and exit points of the existing conduit in previously disturbed areas. It is anticipated that there would be *no impacts* to terrestrial vegetation resources at the programmatic level because the activities that would be conducted at these small entry and exit points are not likely to produce perceptible changes.
  - Use of Existing Buried or Aerial Fiber Optic Plant or Existing Submarine Cable: Lighting up of dark fiber would have *no impacts* to terrestrial vegetation resources because there would be no ground disturbance.
- Satellites and Other Technologies
  - Satellite-Enabled Devices and Equipment: It is anticipated that the installation of permanent equipment on existing structures and the use of portable devices that use satellite technology would not impact terrestrial vegetation resources because those activities would not require ground disturbance or vegetation clearing.

- Deployment of Satellites: FirstNet does not anticipate launching satellites as part of the deployment of the nationwide public safety broadband network (NPSBN); however, it could include equipment on satellites that are already being launched for other purposes. Adding equipment to an existing launch vehicle would not be expected to impact vegetation, and it is anticipated that this activity would have *no impact* to terrestrial vegetation resources.

Activities with the Potential to Have Impacts

Potential deployment-related impacts to terrestrial vegetation resources as a result of implementation of the Preferred Alternative would encompass a range of potential impacts that could occur as a result of ground disturbance activities, including vegetation and habitat loss, alteration, or fragmentation, and invasive species effects. The types of infrastructure development scenarios or deployment activities that could be part of the Preferred Alternative and result in potential impacts to terrestrial vegetation resources include the following activities:

- Wired Projects
  - New Build–Buried Fiber Optic Plant: Plowing (including vibratory plowing), trenching, or directional boring and the construction of points of presence,[5] huts, or other associated facilities or hand-holes to access fiber would require ground disturbance that would likely result in vegetation loss.[6] In addition, ground disturbance and heavy equipment use associated with excavation activities and landscape grading for constructing points of presence, huts, or other associated facilities or hand-holes to access fiber could also result in vegetation clearing or loss. Furthermore, in some build-out locations, short-term and localized potential impacts to terrestrial vegetation could occur as a result of invasive or noxious weed establishment if local conditions and ground disturbance creates an environment conducive to their spreading. However, BMPs and mitigation measures[7] to promptly and properly revegetate disturbed areas could help further reduce these potential impacts.
  - New Build–Aerial Fiber Optic Plant: Topsoil removal, soil excavation, and excavated material placement during the installation of new poles could result in ground disturbance and vegetation loss. Additionally, forested areas would likely need to be permanently converted to and maintained as shrub/grassland in the permanent right-of-way. In some build-out locations, short-term and localized potential impacts to terrestrial vegetation could occur as a result of invasive or noxious weed establishment if local conditions and ground disturbance creates an environment conducive to their spreading. However, BMPs and mitigation measures to promptly and properly revegetate disturbed areas could help further reduce these potential impacts.

[5] Points of presence are connections or access points between two different networks, or different components of one network.
[6] See Section 2.1.2, Proposed Action Infrastructure, for a description of the types of infrastructure to be potentially implemented and explanations of specific techniques and terms.
[7] BMPs and mitigation measures to help minimize potential impacts to terrestrial vegetation resources are listed in Chapter 11, BMPs and Mitigation Measures.

- Collocation on Existing Aerial Fiber Optic Plant: Collocation would involve mounting or installing equipment (such as antennas or microwave dishes) on an existing tower, which would result in *no impact* to terrestrial vegetation because there would be no ground disturbance or vegetation clearing associated with this activity. The potential addition of power units, structural hardening, and physical security measures would not impact vegetation if these activities would not require ground disturbance or vegetation clearing. However, topsoil removal, soil excavation, and excavated material placement during the replacement of poles and structural hardening (should that be required) could result in ground disturbance and vegetation loss. However, it is anticipated that in most cases there would generally be less soil disturbance compared to a new build project. If that is the case, there would likely be correspondingly fewer potential impacts to terrestrial vegetation. In some build-out locations, short-term and localized potential impacts to terrestrial vegetation could occur as a result of invasive or noxious weed establishment if local conditions and ground disturbance creates an environment conducive to their spreading. However, BMPs and mitigation measures to promptly and properly revegetate disturbed areas could help further reduce these potential impacts.
- New Build–Submarine Fiber Optic Plant: The installation of cables in limited near-shore or inland bodies of water would have *no impact* terrestrial vegetation because there would be no ground disturbance associated with this activity (see Section 8.2.6.5, Fisheries and Aquatic Habitats, for a discussion of potential impacts to aquatic habitat). However, potential impacts to vegetation could potentially occur as result of the construction of landings and/or facilities on shore to accept submarine cable. Soil disturbance and vegetation loss could occur as a result of grading, foundation excavation, or other ground disturbance activities. Furthermore, in some build-out locations, short-term and localized potential impacts to terrestrial vegetation could occur as a result of invasive or noxious weed establishment if local conditions and ground disturbance creates an environment conducive to their spreading. However, BMPs and mitigation measures to promptly and properly revegetate disturbed areas could help further reduce these potential impacts.
- Installation of Optical Transmission or Centralized Transmission Equipment: If installation of transmission equipment would occur in existing boxes or huts and require no ground disturbance or vegetation clearing, there would be *no impacts* to terrestrial vegetation. However, if installation of transmission equipment would require vegetation clearing, landscape grading, or other ground disturbance to install small boxes, huts, or access roads, there would be potential impacts to terrestrial vegetation. In some build-out locations, short-term and localized potential impacts to terrestrial vegetation could occur as a result of invasive or noxious weed establishment if local conditions and ground disturbance creates an environment conducive to their spreading. However, BMPs and mitigation measures to promptly and properly revegetate disturbed areas could help further reduce these potential impacts.

- Wireless Projects
  - New Wireless Communication Towers: Installation of new wireless towers and associated structures (generators, equipment sheds, fencing, security and aviation lighting, electrical feeds, and concrete foundations and pads) or access roads could result in potential impacts to terrestrial vegetation resources. Excavation activities, landscape grading, and other ground disturbance activities during the installation of new wireless towers and associated structures or access roads would likely result in vegetation loss. Furthermore, in some build-out locations, short-term and localized potential impacts to terrestrial vegetation could occur as a result of invasive or noxious weed establishment if local conditions and ground disturbance creates an environment conducive to their spreading. However, BMPs and mitigation measures to promptly and properly revegetate disturbed areas could help further reduce these potential impacts.
  - Collocation on Existing Wireless Tower, Structure, or Building: Collocation would involve mounting or installing equipment (such as antennas or microwave dishes) on an existing tower, which would not result in impacts to terrestrial vegetation. However, if the onsite delivery of additional power units, structural hardening, and physical security measures required ground disturbance or resulted in vegetation loss, such as grading or excavation activities, potential impacts to vegetation resources would occur. It is anticipated that in most cases there would generally be less soil disturbance compared to a new build project. If that is the case, there would likely be correspondingly fewer potential impacts to terrestrial vegetation. Furthermore, in some build-out locations, short-term and localized potential impacts to terrestrial vegetation could occur as a result of invasive or noxious weed establishment if local conditions and ground disturbance creates an environment conducive to their spreading. However, BMPs and mitigation measures to promptly and properly revegetate disturbed areas could help further reduce these potential impacts.
- Deployable Technologies
  - Where deployable technologies would be located on existing paved surfaces, it is anticipated that there would be *no impacts* to terrestrial vegetation resources because there would be no new ground disturbance or vegetation clearing required. However, implementation of deployable technologies could result in potential impacts to terrestrial vegetation if deployment of land-based or aerial deployables occurs in unpaved areas and results in vegetation loss. Some staging areas could require land clearing, excavation, and paving, which would result in vegetation loss. Furthermore, in some build-out locations, short-term and localized potential impacts to terrestrial vegetation could occur as a result of invasive or noxious weed establishment if local conditions and ground disturbance creates an environment conducive to their spreading. However, BMPs and mitigation measures to promptly and properly revegetate disturbed areas could help further reduce these potential impacts.

In general, the abovementioned activities could potentially involve land clearing, topsoil removal, excavation, excavated material placement, trenching or directional boring, construction of access roads and other impervious surfaces, landscape grading, and heavy equipment movement. Potential impacts to terrestrial vegetation resources associated with deployment of this infrastructure could include vegetation loss and invasive species effects. These potential impacts are described further below. See Chapter 11, BMPs and Mitigation Measures, for a listing of BMPs and mitigation measures that FirstNet and/or their partners would require, as practicable or feasible, to help avoid or minimize potential impacts.

Potential Vegetation Loss Impacts

Based on the analysis of the deployment activities described above related to terrestrial vegetation resources, potential impacts as a result of vegetation loss are anticipated to be *less than significant* at the programmatic level (see Table 8.2.6.2-1).[8] As mentioned previously, even if certain forested areas would be impacted that require more than several years to become re-established or would be permanently converted to a different cover type, the magnitude/intensity and geographic extent of the vegetation loss is anticipated to be *less than significant* at the programmatic level, and could be further reduced with the implementation of BMPs and mitigation measures. See Chapter 11, BMPs and Mitigation Measures, for a listing of BMPs and mitigation measures that FirstNet and/or their partners would require, as practicable or feasible, to help avoid or minimize the potential vegetation loss.

Potential Invasive Species Impacts

Based on the analysis of proposed activities described above, invasive species effects could result in potentially *less than significant* impacts at the programmatic level since it is anticipated that the proposed activities would not lead to measureable increases in invasive species populations, would be localized to individual build-out locations, and would result in changes that could be reversed over one or two growing seasons or less (see Table 8.2.6.2-1). See Chapter 11, BMPs and Mitigation Measures, for a listing of BMPs and mitigation measures that FirstNet and/or their partners would require, as practicable or feasible, to help avoid or minimize the potential vegetation loss impacts.

Potential Operation Impacts

As described in Section 2.1.2, Proposed Action Infrastructure, operation activities associated with the Preferred Alternative would consist of routine maintenance and inspection of the facilities. Any major infrastructure replacement as part of ongoing system maintenance could result in potential impacts similar to the abovementioned potential deployment impacts. It is anticipated that there would be *no impacts* to vegetation at the programmatic level associated with routine inspections of the Preferred Alternative, assuming that the same access roads used for deployment are also used for inspections. If vegetation clearing/trimming or new ground

[8] Potential impacts to wildlife as a result of vegetation and habitat loss, alteration, or fragmentation as well as a listing of applicable BMPs and mitigation measures are discussed in Section 8.2.6.4, Wildlife, and Chapter 11, BMPs and Mitigation Measures respectively.

disturbance occurs off established access roads or corridors as part of maintenance or inspection activities, *less than significant* vegetation loss impacts could potentially result, similar to the abovementioned deployment impacts, although impacts would likely be lesser in magnitude and extent.

Some studies have indicated the potential for adverse effects to vegetation from RF emissions. As explained in Section 2.4, Radio Frequency Emissions, as well as Section 8.2.6.4, Wildlife, additional, targeted research needs to be conducted to more fully document the nature and effects of RF exposure, including the potential impacts to vegetation.

Alternatives Impact Assessment

The following section assesses potential impacts to terrestrial vegetation associated with the Deployable Technologies Alternative and the No Action Alternative.[9]

Deployable Technologies Alternative

Under the Deployable Technologies Alternative, a nationwide fleet of mobile land-based and aerial communications systems would provide temporary coverage in areas not covered by the existing, usable infrastructure. There would be no collocation of equipment and no new construction associated with wired or wireless projects discussed above under the Preferred Alternative. Some limited construction could be associated with implementation such as land clearing or paving for parking or staging areas. The specific infrastructure associated with the Deployable Technologies Alternative would be the same as the deployable technologies implemented as part of the Preferred Alternative but would likely be implemented in greater numbers, over a larger geographic extent, and used with greater frequency and duration. Potential impacts to terrestrial vegetation resources as a result of implementation of this alternative are described below.

Potential Deployment Impacts

As explained above, implementation of land-based deployable technologies could result in *no impacts* if the deployment occurs on paved or previously disturbed surfaces and *less than significant* impacts to terrestrial vegetation resources at the programmatic level if deployment occurs in unpaved areas and results in vegetation loss, or if the implementation results in paving of previously unpaved vegetated surfaces. Potential impacts to vegetation could also occur if ground disturbance of the deployable vehicle(s) creates an environment conducive to invasive plant species and they become established; however, those potential impacts, as explained above, would also be *less than significant* at the programmatic level. In addition, some staging or landing areas (depending on the type of technology) could require land clearing, minimal excavation, and paving, which could result in less than significant vegetation loss at the programmatic level. BMPs and mitigation measures could help to minimize the spread of noxious and invasive weeds. See Chapter 11, BMPs and Mitigation Measures, for a listing of BMPs and mitigation measures that FirstNet and/or their partners would require, as practicable

[9] As mentioned above and in Section 2.1.2, Proposed Action Infrastructure, the Preferred Alternative includes implementation of deployable technologies.

or feasible, to help avoid or minimize the potential vegetation loss and/or invasive species impacts.

Potential Operation Impacts

As explained above, operation activities would consist of implementation/running of the deployable technology and routine maintenance and inspections. As with the Preferred Alternative, there would be *no impacts* anticipated to terrestrial vegetation associated with routine inspections of the Deployable Technologies Alternative, assuming that the same access roads used for deployment are also used for inspections. If usage of heavy equipment as part of routine maintenance or inspections occurs off of established access roads or corridors and results in ground disturbance or land clearing, vegetation loss and/or invasive species effects could result in *less than significant* impacts at the programmatic level as previously explained above. See Chapter 11, BMPs and Mitigation Measures, for a listing of BMPs and mitigation measures that FirstNet and/or their partners would require, as practicable or feasible, to help avoid or minimize the potential vegetation loss and/or invasive species impacts.

No Action Alternative

Under the No Action Alternative, the NPSBN would not be deployed; therefore, there would be no associated construction or installation of wired, wireless, deployable infrastructure or satellites and other technologies. As a result, there would be *no impacts* to terrestrial vegetation resources because there would be no deployment or operation of the Proposed Action. Environmental conditions would therefore be the same as those described in Section 8.1.6.3, Terrestrial Vegetation.

8.2.6.4. Wildlife

Introduction

This section describes potential impacts to wildlife resources in Puerto Rico associated with deployment and operation of the Proposed Action. Mitigation measures, as defined through permitting and/or consultation with the appropriate resource agency, would be implemented as part of deployment and operation of the Proposed Action to help avoid or reduce potential impacts to wildlife resources. Implementation of best management practices (BMPs), as practicable or feasible, could further reduce the potential for impacts. Both mitigation measures and BMPs are discussed in Chapter 11, BMPs and Mitigation Measures. Potential impacts to amphibians and reptiles, terrestrial mammals, marine mammals, birds, and terrestrial invertebrates occurring in Puerto Rico and Puerto Rico's offshore environments are discussed in this section.

Impact Assessment Methodology and Significance Criteria

The potential impacts of the Proposed Action on wildlife resources were evaluated using the significance criteria presented in Table 8.2.6.2-1. As described in Section 8.2, Environmental Consequences, the categories of potential impacts are defined at the programmatic level as *potentially significant*, *less than significant with BMPs and mitigation measures incorporated*, *less than significant*, or *no impact*. Characteristics of each impact type, including magnitude or intensity, geographic extent, and duration or frequency, were used to determine the impact significance rating associated with each potential impact.

Given the nature of this programmatic evaluation, and because the Proposed Action could potentially cover a wide variety of actions that would take place in various landscapes, the potential impacts to wildlife resources addressed in this section are presented as a range of possible impacts.

Description of Environmental Concerns

Direct Injury/Mortality

Direct injury/mortality effects are physical injuries, extreme physiological stress, or death of an individual organism from interactions associated with the Proposed Action. In general, the most common direct injuries from development projects are entanglement, vehicle strike, problems associated with accidental ingestion, and injuries incurred by sensitive animals, like marine mammals, from disturbance events. Direct injury/mortality environmental concerns pertaining to Puerto Rico's amphibians and reptiles, terrestrial mammals, marine mammals, birds, and terrestrial invertebrates are described below.

Amphibians and Reptiles

Puerto Rico's amphibians and reptiles can be found in a variety of habitats throughout the island and thus may be vulnerable to direct injury and mortality at many of the Proposed Action's potential localities. Direct mortality to amphibians and reptiles could occur in construction zones either by excavation activities or by vehicle strikes; however, these events are expected to be temporary and isolated, affecting only individual animals. Environmental consequences pertaining to Puerto Rico's protected amphibians and reptiles (including sea turtles) are discussed in Section 8.2.6.6, Threatened and Endangered Species and Species of Conservation Concern.

Terrestrial Mammals

Bat species are the only native mammals to Puerto Rico and are described in the Affected Environment Section 8.1.6.4, Wildlife. The United States Fish and Wildlife Service (USFWS) considers Puerto Rico's bats to be species of concern (*USFWS 2015*). Environmental consequences and effects to bat species are discussed in Section 8.2.6.6, Threatened and Endangered Species and Species of Conservation Concern.

Vehicle strikes are sources of direct mortality or injury to terrestrial mammals in Puerto Rico. Individual injury or mortality as a result of vehicle strikes associated with the Proposed Action could occur; however, these events are expected to be temporary and isolated, affecting only individual mammals.

Potential impacts of fences or other barriers on wildlife could be a source of mortality or injury to terrestrial mammals. Bats frequently incur injuries from collisions or entanglements in fences (*Amesbury 2007*). Fences or other barriers can also effectively corral wildlife toward roadways where vehicular traffic increases strike mortality. Entanglement resulting from wildlife attempting to traverse under or over the barrier is also of concern, as animals can get appendages caught. However, potential impacts of fences or other barriers would likely be isolated, individual events.

Marine Mammals

Underwater sound sources, if intense enough, could cause injury or death to marine mammals in the vicinity of the activity. However, given the limited amount of near-shore deployment activities, it is unlikely this would result in population-level impacts and would be isolated, individual events. BMPs and mitigation measures (described in Chapter 11, BMPs and Mitigation Measures) could further help to minimize potential impacts from underwater noise.

Direct mortality and injury to marine mammals as a result of vessel strikes could occur but are not likely to be widespread or affect populations of species as a whole. Implementation of BMPs and mitigation measures (described in Chapter 11, BMPs and Mitigation Measures) could further reduce potential impacts. Mitigation measures that are the result of consultations with the National Marine Fisheries Service would be followed, as required.

Birds

Mortalities from collisions or electrocutions with manmade cables and wires are environmental concerns for avian species with some species covered under the Migratory Bird Treaty Act and the Endangered Species Act. Generally, collision events occur to "poor" fliers (such as ducks), heavy birds (such as swans), and birds that fly in flocks. Species susceptible to electrocution are birds of prey and thermal soarers[1] like the magnificent frigatebird (*Fregata magnificens*) that typically have large wing spans. Avian mortalities or injuries can also result from vehicle strikes and nest disturbance during construction activities, although they typically occur as isolated events.

Direct mortality and injury to birds of Puerto Rico are not likely to be widespread or affect populations of species as a whole and could be further reduced by implementing BMPs and mitigation measures (described in Chapter 11, BMPs and Mitigation Measures). Mitigation measures that are a result of early consultations with the U.S. Fish and Wildlife Service (USFWS) regarding potential impacts to migratory birds would be implemented, as required.

Terrestrial Invertebrates

Ground disturbance or land clearing activities as well as use of heavy equipment and vehicle strikes could result in direct injury or mortality to terrestrial invertebrates. However, deployment activities are expected to be temporary and isolated, thereby limiting the potential for direct mortality and likely affecting only a small number of terrestrial invertebrates.

Vegetation and Habitat Loss, Alteration, or Fragmentation

Potential habitat impacts are primarily physical perturbations that result in alterations in the amount or quality of a habitat. As with all of the effects categories, the magnitude of the potential impact depends on the duration, location and spatial scale of the system and associated activities. Habitat fragmentation is the breaking down of continuous and connected habitat, and impeding access to resources and mates.

Additionally, habitat loss can occur through exclusion, directly or indirectly, preventing an animal from accessing an optimal habitat (e.g., breeding, forage, or refuge), either by physically preventing use of a habitat or by causing an animal to avoid a habitat, either temporarily or long-term. It is expected that activities associated with the Proposed Action would cause isolated, temporary exclusion effects only in very special circumstances.

Potential effects of vegetation and habitat loss, alteration, or fragmentation are described for Puerto Rico's wildlife species below.

[1] Soarers are birds that fly to a considerable altitude and maintain elevation without moving their wings by using ascending air currents. This is done because soaring is much more energy efficient than flapping their wings and soarers generally hunt from the air and so spend a lot of time waiting for prey.

Amphibians and Reptiles

In general, amphibian species utilize aquatic habitats for some part of their life cycle. Amphibian species have a complex life cycle (i.e., having both larval and adult stages) and require aquatic habitats, such as vernal pools,[2] temporary ponds, and even streams for mating, egg laying, and larval growth. Aquatic habitats are naturally dynamic, often filling and drying on an annual basis. Amphibians associated with these habitat types are specifically adapted to such processes.

Filling or draining of wetland breeding habitat and alterations to ground or surface water flow associated with the Proposed Action could have effects to Puerto Rico's amphibian and reptile populations, although given the abundance of amphibians and reptiles found in Puerto Rico, the Proposed Action is likely to only affect a small number of the overall population. Implementation of BMPs and mitigation measures (described in Chapter 11, BMPs and Mitigation Measures) could further help to minimize the potential impacts.

The activities associated with the Proposed Action (see below) could cause disturbance and result in temporary displacement of amphibians and reptiles. Some limited amount of infrastructure may be built in these sensitive areas that could permanently displace small numbers of amphibians and/or reptiles. Implementation of BMPs and mitigation measures could further help minimize potential impacts.

Terrestrial Mammals

The loss of foraging and roosting habitats is common problems for bat populations in the Caribbean (*Gannon et al. 2005*). Natural roost sites can be critical limiting factors for bats (*Lindsay et al. 2008*). Removal or loss of forest also decreases foraging habitat and could potentially impact bats like Pallas' Mastiff (*Molossus molossus*) that are dependent on the forest for the diversity and numbers of flying insects. Habitat loss, fragmentation, or alteration effects would likely be temporary and/or isolated. Implementation of BMPs and mitigation measures (described in Chapter 11, BMPs and Mitigation Measures) could further reduce potential impacts.

Though rainy periods replenish temporary pools, freshwater sources are vulnerable to habitat fragmentation (*Lindsay et al. 2008*). Alterations to ground and surface water flow from development associated with the Proposed Action would likely be temporary and isolated. Implementation of BMPs and mitigation measures (described in Chapter 11, BMPs and Mitigation Measures) could further reduce potential impacts.

[2] Vernal pools are formed in basin depressions and are ponded only during the wetter part of the year; also known as ephemeral pools (*USEPA 2015*).

Marine Mammals

The waters of the Caribbean serve as primary habitat for a range of critical activities including feeding, mating, and calving. Some marine mammals occupy a relatively well-defined habitat year-round or have a narrow feeding niche that restricts them to a particular kind of habitat (e.g., West Indian manatees [*Trichechus manatus*]) need access to aquatic vegetation and warm water). Environmental consequences to protected marine mammals (including the West Indian manatee) are discussed in Section 8.2.6.6, Threatened and Endangered Species and Species of Conservation Concern.

Whales, dolphins, and manatees may be temporarily excluded from a resource if they avoid it due to the increased noise associated with human activity. Depending on the duration of the activity, marine mammals could be excluded from their environment temporarily or could abandon the habitat entirely (*Richardson et al. 1995*). However, the degree to which habitat exclusion affects marine mammals depends on many factors. Whales and dolphins are mobile and generally use open water habitat; therefore, it is expected that sea-based activities from the Proposed Action, which would be limited to small boats in near-shore and inland waters, would not affect the ability of marine mammals to access important resources.

Birds

The removal and loss of vegetation can affect avian species directly by loss of nesting, foraging, and cover habitat. Displacement of migratory birds from feeding, nesting, or molting areas is of particular concern in Puerto Rico because the islands are important stopovers for resting and replenishing energy stores as well as wintering habits.

Noise disturbance and human activity, as discussed previously, could directly restrict birds from using their preferred resources. Greater human activity of longer duration could increase the likelihood that birds would avoid the area, possibly being excluded from essential resources.

The degree to which habitat exclusion affects birds depends on many factors, which could include, but are not limited to, life history and behavior of species, stage of the annual cycle being affected, or degree of habitat disturbance. For example, the potential impact to passerine[3] species from disturbance or displacement from construction activities is likely to be short-term with minor effects from exclusion. The potential impact could be greater to solitary nesters (e.g., ducks) or colony nesters (e.g., seabirds). Exclusion from resources concentrated in a small migratory stop area during peak migration could have potential impacts to species that migrate in large flocks and concentrate at stop overs (e.g., shorebirds) (*Hockin et al. 1992; Korschgen et al. 1985*). However, deployment activities are expected to be temporary and isolated, likely affecting only a small number of birds. Potential impacts to birds could be further reduced by implementation of BMPs and mitigation measures (described in Chapter 11, BMPs and Mitigation Measures) and with early coordination with USFWS staff.

[3] Passerines are an order of "perching" birds that have four toes, three facing forward and one backward, which allows the bird to easily cling to both horizontal and nearly vertical perches.

Terrestrial Invertebrates

Terrestrial invertebrates could be displaced or disturbed by activity associated with the Proposed Action on the islands. Proposed Action activities that could affect terrestrial invertebrates are expected to be temporary and isolated, affecting only small numbers of terrestrial invertebrates. Potential impacts could be further reduced by the implementation of BMPs and mitigation measures (described in Chapter 11, BMPs and Mitigation Measures).

Indirect Injury/Mortality

"Indirect effects" are effects that are caused by the action and are later in time or farther removed in distance, but are still reasonably foreseeable (*40 CFR § 1508.8[b]*). Indirect injury/mortality can include stress related to disturbance and disruption of life history patterns (such as migration and breeding) important for survival. A short-term stress response to an acute, temporary stressor initiates a "fight or flight" response that diverts energy (which would otherwise be used for reproduction and growth) to the immediate survival of the animal (*Reeder and Kramer 2005*). Most organisms are well adapted and recover quickly from these types of stressors. A chronic stress response to a persistent stressor; however, can be detrimental to the organism and result in cell death, compromised immune system, muscle wasting, reproductive suppression, and memory impairment (*Reeder and Kramer 2005*). Potential indirect injury/mortality impacts vary depending on the species, time of year, and duration of deployment. However, deployment activities are expected to be temporary and isolated, likely affecting only a small number of wildlife. Potential impacts to wildlife could be further reduced by implementation of BMPs and mitigation measures (described in Chapter 11, BMPs and Mitigation Measures).

See Section 2.4, Radio Frequency Emissions, for additional information on potential radio frequency (RF) exposure impacts.

Amphibians and Reptiles

As previously discussed, amphibians have complex aquatic life cycles. Changes in water quality and quantity and loss of wetlands and vernal pools, especially during the breeding seasons, reduce the number and density of breeding sites, leading to lower productivity and diminishing the capacity to maintain local and regional species populations (*Semlitsch 2000*). However, changes in water quality or quantity are expected to be temporary and isolated, affecting at most only a limited number of amphibians.

Reptiles are generally more hardy animals than amphibians, occupy more diverse habitats, and can tolerate longer periods without food and water. However, reptiles are still susceptible to stress from changes in their environment (*ScienceNordic 2012*).

Terrestrial Mammals

Stress from repeated disturbances during critical time periods (e.g., maternity and weaning periods, inactivity) can reduce the overall fitness and productivity of young and adult terrestrial mammals. For example, bats are particularly vulnerable to disturbance during periods of torpor (when arousal affects their ability to conserve energy) and during the breeding season (when they are gathered in maternity colonies where disturbance may cause a decline in breeding success) (*Gannon et al. 2005*). Bats in poor body condition are more susceptible to disease (*Gannon et al. 2005*). Potential indirect injury or mortality to bat species as a result of the Proposed Action is discussed in Section 8.2.6.6, Threatened and Endangered Species and Species of Conservation Concern.

There are no published studies that document physiological or other adverse effects to bats from RF exposure. However, because bats are similar ecologically and physiologically to birds, they have the potential to be affected by RF exposure in similar ways to birds (see the birds subsection below). One study demonstrated that foraging bats avoided areas exposed to varying levels of electromagnetic radiation compared with control sites, and attributed this behavior to the increased risk of overheating and echolocation interference caused by electromagnetic field exposure (*Nicholls and Racey 2009*). As stated below, experts emphasize that targeted field research needs to be conducted to more fully document the nature and extent of effects of RF exposure on bats and other wildlife, and the implications of those effects on populations over the long term (*Manville 2015 and 2016*; Appendix H, *Radio Frequency Emissions Comments Received—All Regions*). FirstNet recognizes that RF exposure has the potential to adversely impact bats, particularly bats that communally roost or breed and nurture young in areas with RF exposure, and concurs with the need for further research. As such, and as a precaution, FirstNet and/or their partners would implement BMPs and mitigation measures that focus on siting towers away from known communal bat use areas to the extent practicable or feasible (described in Chapter 11, BMPs and Mitigation Measures). See Section 2.4, Radio Frequency Emissions, for additional information on potential RF exposure impacts.

Marine Mammals

As discussed above, Caribbean waters are primary habitat for feeding, calving, and mating. Repeated disturbance, especially near calving or foraging areas, can cause behavioral changes such as alteration or cessation of feeding, nursing, or resting. These behavioral changes can increase an animal's energy expenditure or result in chronic levels of stress, which could have an adverse effect on health (*Parsons 2012*). Additional behavioral changes observed in cetacean species in response to disturbance include changes in surfacing, acoustic, and swimming behavior and changes in direction, group size, and coordination, all of which can result in additional energetic cost (*Parsons 2012*). However, deployment activities would only take place in near-shore environments and are expected to be temporary and isolated, likely affecting only individual marine mammals.

Indirect effects from displacement or habitat damage could include lowered fitness as a result of increased energetic challenges, either as added travelling costs or reduced foraging opportunities. However, deployment activities would only take place in near-shore environments and are expected to be temporary and isolated, likely affecting only individual marine mammals. Indirect effects from displacement or habitat damage could include lowered fitness as a result of increased energetic challenges, either as added travelling costs or reduced foraging opportunities. However, any deployment activities taking place in near-shore environments are expected to be temporary and isolated, likely affecting only individual marine mammals (as opposed to population or subpopulation level impacts). Indirect effects as a result of displacement and disturbance could be further minimized through the use of BMPs and mitigation measures (described in Chapter 11, BMPs and Mitigation Measures).

Birds

Nest abandonment can result from human-induced disturbance during the breeding/nesting season. Disturbance during migration has been shown to adversely affect grazing geese, shorebirds and lowland and upland terrestrial species (*Hockin et al. 1992*). Most waterfowl and shorebirds take to flight when disturbed; displacing them from preferred feeding or roosting areas and increasing energetic demands (*Tuite et al. 1983; Bell and Austin 1985; Cryer et al. 1987; Belanger and Bedard 1989*) or leading them to abandon areas completely (*Bell and Austin 1985; Korschgen et al. 1985; Burger 1986*). A shift from preferred to less preferred feeding areas is likely to affect feeding efficiency (*Burger 1988*).

Repeated disturbance, especially during the breeding and nesting season, could cause stress to individuals lowering fitness and productivity. However, deployment activities are expected to be temporary and isolated, likely affecting only a small number of birds. Potential disturbance-related impacts to birds could be further reduced by implementation of BMPs and mitigation measures (described in Chapter 11, BMPs and Mitigation Measures).

Research indicates that RF exposure may adversely affect birds. A comment letter on the Draft Programmatic Environmental Impact Statement for the Western U.S. presented by Dr. Albert Manville, former USFWS agency lead on avian-structural impacts, summarizes the state of scientific knowledge of the potential effects of RF exposure on wildlife, particularly migratory birds; the comment letter is presented in its entirety in Appendix H. RF exposure may result in adverse impacts on wildlife, although a distinct causal relationship between RF exposure and responses in wild animal populations has not been established. Further, important scientific questions regarding the mechanisms of impact, the exposure levels that trigger adverse effects, and the importance of confounding factors in the manifestation of effects, among other questions, remain unanswered (*Manville 2016*; Appendix H).

Research conducted to date under controlled laboratory conditions has identified a wide range of physiological and behavioral changes in avian and mammalian subjects, including embryonic mortality in bird eggs, genetic abnormalities, cellular defects, tumor growth, and reproductive and other behavioral changes in adult birds and rodents (*Wyde 2016; Levitt and Lai 2010; Di Carlo et al. 2002; Grigor'ev 2003; Panagopoulos and Margaritas 2008*).

Few studies of the effects of RF exposure on wild animal populations have been conducted due to the difficulty of performing controlled studies on wild subjects. Those that have been conducted are observational in nature (i.e., documenting of reproductive success and behavior in birds near RF-emitting facilities). These studies lack controls on exposure levels or other potentially confounding factors. Nevertheless, findings from these studies indicate reduced survivorship at all life stages; physiological problems related to locomotion and foraging success; and behavioral changes that resulted in delayed or unsuccessful mating in several species of nesting birds (*Balmori 2005 and 2009; Balmori and Hallberg 2007; Manville 2016*; Appendix H). Balmori (*2005*) documented effects as far as 1,000 feet from an RF source consisting of multiple cellular phone towers. Another study of wild birds conducted by Engels et al. (*2014*) documented that migratory birds are unable to use their magnetic compass in the presence of urban electromagnetic noise,[4] which can disrupt migration or send birds off course, potentially resulting in reduced survivorship.

Experts emphasize that targeted field research needs to be conducted to more fully document the nature and extent of effects of RF exposure on birds and other wildlife and the implications of those effects on wildlife populations over the long term (*Manville 2015; Manville 2016*; Appendix H). Such studies should be conducted over multiple generations and include controls to more clearly establish causal relationships, identify potential chronic effects, and determine threshold exposure levels. FirstNet recognizes that RF exposure may adversely impact wildlife, particularly birds that nest, roost, forage, or otherwise spend considerable time in areas with RF exposure, and concurs with the need for further research. As such, and as a precaution, FirstNet and/or their partners would implement BMPs and mitigation measures that focus on siting towers away from high bird use areas to the extent practicable or feasible (described in Chapter 11, BMPs and Mitigation Measures). See Section 2.4, Radio Frequency Emissions, for additional information on potential RF exposure impacts.

Terrestrial Invertebrates

Terrestrial invertebrates could experience chronic stress either by changes in habitat composition or competition for resources, resulting in lower productivity. However, the overall abundance of terrestrial invertebrate populations of Puerto Rico is not expected to be affected by indirect mortality or injury events.

Effects to Migration or Migratory Patterns

Migration is the regular movement of animals from one region to another and back again. Migratory patterns vary by species and sometimes within the same species. Potential effects to migration patterns of Puerto Rico's amphibians and reptiles, terrestrial mammals, marine mammals, birds, and terrestrial invertebrates are described below.

[4] Urban electromagnetic noise is a term used to describe an area with a concentration of cell phone towers and users, which by sheer volume and level of use, creates a zone of electromagnetic noise.

See Section 2.4, Radio Frequency Emissions, for additional information on potential RF exposure impacts.

Amphibians and Reptiles

Reptiles, particularly marine reptiles, typically migrate long distances to nest and feed. Sea turtles are long-distance migrators, swimming long distances to their nesting home range of the tropic and subtropic regions. Green sea turtles perform regular migratory circuits, which take 2 to 3 years (*Cloudsley-Thompson 1999*). Potential effects to migratory patterns are described in Section 8.2.6.6, Threatened and Endangered Species and Species of Conservation Concern.

Species that use streams as dispersal or migratory corridors could potentially be impacted if these waterways are restricted or altered. Restrictions or alterations of waterways are not expected to affect widely distributed populations as a whole. Other amphibian species in Puerto Rico that concentrate in smaller areas and are not widely distributed could potentially be impacted at the population level depending on the amount of resource altered. However as deployment activities would be limited and temporary, it is likely that only individual amphibians would be impacted, rather than entire populations. BMPs and mitigation measures (described in Chapter 11, BMPs and Mitigation Measures) could further help to avoid or minimize potential impacts.

Terrestrial Mammals

Puerto Rico's terrestrial mammals do not have long-distance migratory patterns though some may exhibit short-distance dispersals. Potential impacts can vary depending on the species, time of year of construction/operation, and duration; however, as deployment activities are expected to be temporary and isolated, it is likely the short-distance dispersal of individual terrestrial mammals would be potentially impacted by the Proposed Action. Implementation of BMPs and mitigation measures (described in Chapter 11, BMPs and Mitigation Measures) could further help to avoid or minimize potential impacts. It is likely that the limited number of permanent structures such as towers or access roads would also have a minimal impact on migratory patterns.

Marine Mammals

Several migratory whale species occur in the Caribbean region, including blue, fin, sei, humpback, and common minke whales, as well as the North Atlantic right whale and the sperm whale (*Ward et al. 2001*). Noise associated with the installation of cables in the near/offshore waters of the islands could potentially impact marine mammal migration patterns, though potential impacts are likely to be short-term provided the noise sources are not wide ranging and below Level A and B sound exposure thresholds.[5] Behavioral changes observed in cetacean species in response to disturbance include changes in surfacing, acoustic, and swimming

[5] Level A (minimum exposure criterion for injury at the level at which a single exposure is estimated to cause onset of permanent hearing loss) is 190 decibels (dB) referenced to 1 micro Pascal (µPa) (root mean square [rms]) for seals and 180 dB referenced to 1 µPa (rms) for whales, dolphins, and porpoises. Level B (defined as the onset of significant behavioral disturbance is proposed to occur at the lowest level of noise exposure that has a measurable transient effect on hearing) is 160 dB referenced to 1 µPa (rms) (*Southall et al. 2007*).

behavior and changes in direction, group size, and coordination, all of which can result in additional energetic cost (*Parsons 2012*). It is clear that behavioral responses are strongly affected by the context of exposure and by the animal's experience, motivation, and conditioning. Additionally, as marine mammals have the capacity to divert from sound sources during migration, it is unlikely the Proposed Action would result in migratory impacts. Implementation of BMPs and mitigation measures (described in Chapter 11, BMPs and Mitigation Measures) could further help to avoid or minimize potential impacts.

Birds

Because many bird species have extremely long migrations, protection efforts for critical sites along migratory routes must be coordinated over vast distances often involving many different countries. The Caribbean's location between North American breeding sites and South American wintering grounds makes Puerto Rico an important stopovers for resting and replenishing energy stores (*Nytch et al. 2015*). Many migratory routes are passed from one generation to the next.

Potential impacts can vary depending on the species, time of year of construction/operation, and duration, but may include mortality of individuals or whole population displacement from preferred stopover habitat. The displacement impacts could affect quality and quantity of food resources, refueling rates, and possibly fitness of individual birds. Additionally, there is some evidence in the scientific literature that RF emissions could affect bird migration. Engels et al. (*2014*) documented that migratory birds are unable to use their magnetic compass in the presence of urban electromagnetic noise, which can disrupt migration or send birds off course, potentially resulting in reduced survivorship. It is unlikely that the limited amount of infrastructure, the amount of RF emissions generated by project infrastructure, and the temporary nature of the deployment activities would result in impacts to large populations of migratory birds, but more likely that individual birds could be impacted. Implementation of BMPs and mitigation measures (described in Chapter 11, BMPs and Mitigation Measures) could further help to avoid or minimize potential impacts to migratory pathways.

Terrestrial Invertebrates

Very little is known about migratory behavior in Puerto Rico's terrestrial invertebrates (*Garcia et al. 2005*). It is expected that the majority of terrestrial invertebrates are localized in their movements during their short life spans and as a result, no effects to migratory patterns of Puerto Rico's common terrestrial invertebrates are expected as a result of the Proposed Action. Effects to migration patterns of listed species, such as the Monarch butterfly (*Danaus plexippus*) are discussed in 8.2.6.6, Threatened and Endangered Species and Species of Conservation Concern.

Reproductive Effects

Reproductive effects are considered those that either directly or indirectly reduce an animal's ability to produce offspring or reduce the rates of growth, maturation, and survival of offspring, which can affect the overall population of individuals. See Section 2.4, Radio Frequency Emissions, for additional information on potential RF exposure impacts.

<u>Amphibians and Reptiles</u>

Female Puerto Rican freshwater turtles migrate to limited nesting areas during the reproductive season (*Joglar et al. 2007*). Restricted access to these areas could affect reproductive success. The establishment of exotic freshwater turtles in natural ecosystems inhabited by the Puerto Rican freshwater turtle could affect the reproductive success and recruitment of early life stages of this species (*Joglar et al. 2007*). It is unlikely that the limited amount of infrastructure and the temporary nature of the deployment activities would result in impacts to large populations of nesting amphibians or reptiles, but more likely that individuals could be impacted. Implementation of BMPs and mitigation measures (described in Chapter 11, BMPs and Mitigation Measures) could further help to avoid or minimize potential impacts to nesting amphibians and reptiles.

Reproductive effects to sub-populations of amphibians and reptiles could occur through the loss of habitat if deployment activities occur near breeding wetlands, alter water quality through sediment infiltration, or obstruction of natural water flow to pools. Implementation of BMPs and mitigation measures (described in Chapter 11, BMPs and Mitigation Measures) could help to avoid or minimize potential impacts.

<u>Terrestrial Mammals</u>

Disturbance during critical life phases (maternity and weaning periods) could affect reproductive success of bats in Puerto Rico (*Gannon et al. 2005*), and could result in the abandonment of offspring, leading to reduced survival. It is, however, unlikely that the limited amount of infrastructure and the temporary nature of the deployment activities would impact the life phases of large numbers of bats. It is more likely that individual bats could be affected. Additionally, the implementation of BMPs and mitigation measures (described in Chapter 11, BMPs and Mitigation Measures) could further reduce potential impacts.

There are no published studies that document adverse effects to bats from RF exposure. As stated above, experts emphasize that targeted field research needs to be conducted to more fully document the nature and extent of effects of RF exposure on bats and other wildlife, and the implications of those effects on populations over the long term (*Manville 2015 and 2016*; Appendix H). FirstNet recognizes that RF exposure has the potential to adversely impact bats, particularly bats that communally roost or breed and nurture young in areas with RF exposure, and concurs with the need for further research. As such, and as a precaution, FirstNet and/or their partners would implement BMPs and mitigation measures that focus on siting towers away from known communal bat use areas to the extent practicable or feasible (described in

Chapter 11, BMPs and Mitigation Measures). See Section 2.4, Radio Frequency Emissions, for additional information on potential RF exposure impacts.

Marine Mammals

Restricted access to important calving and nursing grounds, including haulouts, has the potential to adversely affect body condition and reproductive success of many marine mammals. As described above, behavioral changes associated with disturbance could also affect mother-infant bonding, reducing survival success of offspring (*Parsons 2012*). Disturbances that could impair socialization (e.g., noise or displacement) can influence reproduction rates through reduced mating opportunities (*Lusseau and Bejder 2007*). As deployment activities are expected to take place only in limited near-shore environments and for a short duration, it is unlikely that marine mammals would experience reproductive impacts. Additionally, implementation of BMPs and mitigation measures (described in Chapter 11, BMPs and Mitigation Measures) could further reduce any reproductive impacts.

Birds

Potential impacts due to Proposed Action deployment and operations could include abandonment of the area and nests due to disturbance. Disturbance (visual and noise) could displace birds into less suitable habitat and thus reduce survival and reproduction. The loss of cays[6] could result in seabird displacement into marginal habitats, increased predation risks, and/or nest abandonment and chick mortality (*Nytch et al. 2015*). Avian tolerance levels to disturbance can be species-specific. Activities related to the Proposed Action, such as aerial deployment or construction activities, could result in flushing birds from nesting areas; however, the temporary nature of the deployment activities would minimize these impacts. Implementation of BMPs and mitigation measures (described in Chapter 11, BMPs and Mitigation Measures) could further help to avoid or minimize potential impacts.

Research conducted to date on RF emissions under controlled laboratory conditions has identified a wide range of physiological and behavioral changes in avian subjects, including embryonic mortality in bird eggs and reproductive changes in adult birds (*Wyde 2016; Levitt and Lai 2010; Di Carlo et al. 2002; Grigor'ev 2003; Panagopoulos and Margaritas 2008*). Laboratory studies conducted with domestic chicken embryos have shown that emissions at the same frequency and intensity as that used in cellular telephones have appeared to result in embryonic mortality (*Di Carlo et al. 2002; Manville 2007*). These studies suggest that RF emissions at low levels (far below the existing exposure guidelines for humans) (see Section 2.4.2, RF Emissions and Humans) may be harmful to wild birds; however, given the controlled nature of the studies and potential exposure differences in the wild, it is unclear how this exposure would affect organisms in the wild.

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[6] Cays are small, low-elevation, sandy islands on the surface of a coral reef.

As such, and as a precaution, FirstNet and/or their partners would implement BMPs and mitigation measures that focus on siting towers away from high bird use areas to the extent practicable or feasible (described in Chapter 11, BMPs and Mitigation Measures). See Section 2.4, Radio Frequency Emissions, for additional information on potential RF exposure impacts.

Terrestrial Invertebrates

Puerto Rico's terrestrial invertebrate species are highly diverse and prevalent. It is expected that the majority of terrestrial invertebrates are wide spread in Puerto Rico and as a result, no population level reproductive effects to terrestrial invertebrates are expected as a result of the Proposed Action.

Invasive Species Effects

The introduction of non-native species is often the result of human activity. Invasive (non-native) species can have a dramatic effect on natural resources and native populations. Non-native species that are introduced into an ecosystem in which they did not evolve often increase rapidly in number. Native species evolve together as a community and function within an ecosystem governed by many checks and balances. Balance evolves within the system that limits the population growth of any one species; for example predators, herbivores, diseases, parasites, and other organisms compete for the same resources under limiting environmental factors. A non-native species, when introduced into an ecosystem in which it did not evolve naturally, is often times not bound by those limits; its numbers can sometimes dramatically increase and have potential severe impacts on the native community and ecosystem. Invasive species are often times very capable of out-competing native species for food and habitats and sometimes may even be attributed to the extinction of native species or potentially impact the species richness in an ecosystem (*USFWS 2012*). Potential invasive species effects to Puerto Rico's wildlife are described below.

Amphibians and Reptiles

The introduction of invasive species such as the Indian mongoose (*Herpestes edwardsii*) could result in intense egg predation of amphibians and reptiles. The establishment of exotic freshwater turtles in natural ecosystems inhabited by the Puerto Rican freshwater turtle can affect the reproductive success and recruitment of early life stages (*Joglar et al. 2007*). As the limited deployment of infrastructure and the short duration of construction activities are unlikely to result in either of the above named species being released, it is unlikely that the Proposed Action would impact amphibians or reptiles through the introduction or further exacerbation of invasive species. Implementation of BMPs and mitigation measures (described in Chapter 11, BMPs and Mitigation Measures) could further reduce potential impacts.

Terrestrial Mammals

Of the extinctions on islands in modern history, rats are estimated to have caused 50 to 81 percent of mammal extinctions (*Ceballos and Brown 1995*).When rats and mongoose arrived on Puerto Rico, local populations of small animals were quickly decimated, often causing local extinctions. Mongoose are also aggressive predators that prey on bats. Invasive species related extinctions occur not only via direct predation, but also by eliminating common prey species used by other mammals. For example, besides eating seeds and small vertebrates, rats prey heavily on insects. This, in turn, can seriously reduce native populations of populations of animals that depend on a diet of insects for survival, such as bats. Other introduced species such as white-tailed deer, hogs, cats, and dogs have been implicated in the local extinctions and/or lower numbers of native species populations (*Platenberg et al. 2005*).

Construction activities do not typically lend themselves to the introduction of invasive wildlife species. Additionally, limited deployment of infrastructure and the short duration of construction activities are unlikely to result in any of the above named species, or any other invasive species, being introduced or further exacerbated, it is unlikely that the Proposed Action would impact terrestrial mammals through the introduction of invasive species. Invasive species effects to terrestrial mammals could be further minimized following the BMPs and mitigation measures described in Chapter 11, BMPs and Mitigation Measures.

Birds

Mangrove nesting bird communities are threatened is depredation by introduced species such as mongoose and feral cats. Seabird populations are particularly susceptible to invasive predators because of their unique life histories. Seabirds are long-lived and many species do not typically reproduce until attaining at least 2-3 years of age. Clutch sizes are typically small and young undergo long fledgling periods. These life history variables manifest in low annual productivity. Seabirds typically nest on the ground or in burrows or crevices, are absent for long periods on forage bouts (e.g., albatross and frigatebirds). Absence for long periods leaves the eggs and young vulnerable to predation (*Moors and Atkinson 1984; Major et al. 2006*).

The most vulnerable are species that forage well away from the coast and are absent from their eggs and young for extended periods, as well as ground nesters such the Puerto Rican nightjar (*Antrostomus noctitherus*), short-eared owl (*Asio flammeus*), black rail (*Laterallus jamaicensis*), Key West quail-dove (*Geotrygon chrysia*), and bridled quail-dove (*Geotrygon mystacea*) (*Nytch et al. 2015*). As the Proposed Action only involves temporary limited near-shore deployment activities, it is unlikely invasive species would be released by the construction activities that could threaten shore-bird populations. Additionally, due to the temporary and limited nature of terrestrial deployment activities, it is also unlikely that invasive species would be introduced or further exacerbated as a result of construction of the Proposed Action. Implementation of BMPs and mitigation measures (described in Chapter 11, BMPs and Mitigation Measures) could further reduce potential impacts associated with invasive species.

Terrestrial Invertebrates

Terrestrial invertebrate populations are susceptible to invasive plant species that could change or alter the community composition of specific plants on which they depend. Effects from invasive plant species to terrestrial invertebrates would be similar to those described for habitat loss and degradation. As the Proposed Action involves temporary and limited deployment actions, it is unlikely that construction activities would result in population-level impacts as a result of the introduction or further exacerbation of invasive species. Implementation of BMPs and mitigation measures (described in Chapter 11, BMPs and Mitigation Measures) could further reduce potential impacts associated with invasive species.

Potential Impacts of the Preferred Alternative

The following section assesses potential impacts associated with implementation of the Preferred Alternative, including construction/deployment and operation activities.

Potential Deployment Impacts

As described in Section 2.1.2, Proposed Action Infrastructure, implementation of the Preferred Alternative could result in the deployment of various types of facilities or infrastructure. Depending on the physical nature and location of the facility/infrastructure and the specific deployment requirements, some activities would result in potential impacts to wildlife resources and others would not. In addition, and as explained in this section, various types of Preferred Alternative infrastructure could result, at the programmatic level, in a range of *no impacts* to *less than significant,* depending on the deployment scenario or site-specific conditions. The wildlife that would be affected would depend on the ecoregion, the species' phenology,[7] and the nature and extent of the habitats affected. Site-specific analysis may be required depending on the site conditions, the type of deployment, or any other permits or permissions necessary to perform the work.

Activities Likely to Have No Impacts

Of the types of facilities or infrastructure development scenarios described in Section 2.1.2, Proposed Action Infrastructure, the following are expected to have *no impacts* to wildlife resources at the programmatic level under the conditions described below:

- Wired Projects
  - Use of Existing Conduit–New Buried Fiber Optic Plant: Disturbance associated with the installation of fiber optic cable in existing conduit would be limited to entry and exit points of the existing conduit in previously disturbed areas. It is anticipated that there would be *no impacts* to wildlife at the programmatic level because the activities that would be conducted at these small entry and exit points are not likely to produce perceptible changes. Additionally noise generated to install fiber would be infrequent and of short duration and unlikely to produce measureable changes in wildlife behavior.

[7] Phenology is the seasonal changes in plant and animal life cycles, such as emergence of insects or migration of birds.

  - Use of Existing Buried or Aerial Fiber Optic Plant or Existing Submarine Cable: Lighting up of dark fiber would have *no impacts* to wildlife because there would be no ground disturbance.
- Satellites and Other Technologies
  - Satellite-Enabled Devices and Equipment: It is anticipated that the installation of permanent equipment on existing structures and the use of portable devices that use satellite technology would have *no impact* to wildlife because those activities would not require ground disturbance.
  - Deployment of Satellites: FirstNet does not anticipate launching satellites as part of the deployment of the nationwide public safety broadband network (NPSBN); however, it could include equipment on satellites that are already being launched for other purposes. As adding equipment to an existing launch vehicle would be very unlikely to impact wildlife resources, it is anticipated that this activity would have *no impact* to those resources.

Activities with the Potential to Have Impacts

Potential construction/deployment-related impacts to wildlife resources as a result of implementation of the Preferred Alternative would encompass a range of potential impacts that could occur, including direct injury/mortality; vegetation and habitat loss, alteration, or fragmentation; effects to migratory patterns; indirect injury/mortality; reproductive effects; and invasive species effects. The types of infrastructure development scenarios or deployment activities that could be part of the Preferred Alternative and result in potential impacts to wildlife resources at the programmatic level include the following:

- Wired Projects
  - New Build–Buried Fiber Optic Plant: Plowing, trenching, or directional boring and the construction of points of presence (POPs),[8] huts, or other associated facilities or hand-holes to access fiber could result in potential impacts to wildlife resources. Land/vegetation clearing and excavation activities, associated with construction of POPs, huts, or other associated facilities could result in direct injury/mortalities of wildlife that are not mobile enough to avoid construction activities (e.g., reptiles, small mammals, and young), that utilize burrows (e.g., ground squirrels), or that are defending nest sites (such as ground-nesting birds). Disturbance, including noise, associated with the above activities could result in habitat loss, effects to migration patterns, indirect injury/mortality, reproductive effects, and invasive species effects. However, deployment activities are expected to be temporary and isolated, likely affecting only a small number of wildlife. Potential impacts to wildlife could be further reduced by implementation of BMPs and mitigation measures (described in Chapter 11, BMPs and Mitigation Measures).

[8] POPs are connections or access points between two different networks, or different components of one network.

- New Build–Aerial Fiber Optic Plant: The installation of new poles and hanging cable and associated security, safety, or public lighting components on public right-of-ways (ROWs) or private easements as well as the construction of access roads, POPs, huts, or facilitates to house outside plant equipment could result in potential impacts to wildlife resources. Potential impacts could vary depending on the number or individual poles installed, but could include direct injury/mortality as described above; habitat loss, alteration, or fragmentation; effects to migratory patterns; indirect injury/mortality; and invasive species effects. However, deployment activities are expected to be temporary and isolated, likely affecting only a small number of wildlife. Potential impacts to wildlife could be further reduced by implementation of BMPs and mitigation measures (described in Chapter 11, BMPs and Mitigation Measures).
- Collocation on Existing Aerial Fiber Optic Plant: Land clearing and excavation during replacement of poles and structural hardening could result in direct injury/mortality, habitat loss or alteration, effects to migratory patterns, indirect injury/mortality, and invasive species effects. Noise disturbance from heavy equipment use associated with these activities as well as with installing new fiber on existing poles could result in migratory effects, indirect injury/mortality, and habitat loss if roost sites are abandoned. However, deployment activities are expected to be temporary and isolated, likely affecting only a small number of wildlife. Potential impacts to wildlife could be further reduced by implementation of BMPs and mitigation measures (described in Chapter 11, BMPs and Mitigation Measures).
- New Build–Submarine Fiber Optic Plant: The installation of cables in limited near-shore or inland bodies of water and construction of landings and/or facilities on the shore to accept submarine cables could potentially impact wildlife, marine mammals in particular (see Section 8.2.4, Water Resources, for a discussion of potential impacts to water resources and Section 8.2.6.6, Threatened and Endangered Species and Species of Conservation Concern, for potential impacts to listed wildlife).[9] Effects could include direct injury/mortality; habitat loss, alteration, or fragmentation. If activities occurred during critical time periods, effects to migratory patterns as well as reproductive effects and indirect injury/mortality could occur. However, deployment activities are expected to be temporary and isolated, likely affecting only a small number of wildlife. Potential impacts to wildlife could be further reduced by implementation of BMPs and mitigation measures (described in Chapter 11, BMPs and Mitigation Measures).
- Installation of Optical Transmission or Centralized Transmission Equipment: If installation of transmission equipment would occur in existing boxes or huts, there would be *no impacts* to wildlife at the programmatic level because no new infrastructure would be created and no disturbance to wildlife would incur. However, if installation of transmission equipment required construction of access roads, trenching, and/or land clearing, such disturbance could result in direct injury/mortality of wildlife as described

[9] Listed wildlife is any animal listed as threatened or endangered by federal or territory agencies.

for other New Build activities. Habitat loss, alteration and fragmentation; effects to migration or migratory patterns, indirect injury/mortality, and invasive species effects could occur as a result of construction and resulting disturbance. However, deployment activities are expected to be temporary and isolated, likely affecting only a small number of wildlife. Potential impacts to wildlife could be further reduced by implementation of BMPs and mitigation measures (described in Chapter 11, BMPs and Mitigation Measures).

- Wireless Projects
  - New Wireless Communication Towers: Installation of new wireless towers and associated structures (generators, equipment sheds, fencing, security and aviation lighting, electrical feeds, and concrete foundations and pads) or access roads could result in potential impacts to wildlife resources. Land/vegetation clearing, excavation activities, landscape grading, and other disturbance activities during the installation of new wireless towers and associated structures or access roads could result in direct injury/mortality, habitat loss, alteration or fragmentation, and effects to migratory patterns. However, deployment activities are expected to be temporary and isolated, likely affecting only a small number of wildlife. Potential impacts to wildlife could be further reduced by implementation of BMPs and mitigation measures (described in Chapter 11, BMPs and Mitigation Measures).
  - Collocation on Existing Wireless Tower, Structure, or Building: Collocation would involve mounting or installing equipment (such as antennas or microwave dishes) on an existing tower, which would not result in impacts to wildlife if no additional disturbance is required to install the hardware on the tower. The potential addition of power units, structural hardening, tower replacement, and physical security measures such as lighting could potentially impact wildlife resources resulting in direct injury/mortality from disturbance activities that could occur during the installation of new equipment. However, deployment activities are expected to be temporary and isolated, likely affecting only a small number of wildlife. Potential impacts to wildlife could be further reduced by implementation of BMPs and mitigation measures (described in Chapter 11, BMPs and Mitigation Measures). Refer to Section 2.4, Radio Frequency Emissions, for information on radio frequency concerns.
- Deployable Technologies
  - In general, some limited construction could be associated with the implementation of deployable technologies such as land clearing or paving for parking or staging areas. This could lead to vegetation and habitat loss, alteration, or fragmentation. Implementation of deployable technologies themselves, including Cell on Wheels, Cell on Light Truck, or System on Wheels, could result in direct injury/mortalities to wildlife on roadways as well as bird strike hazards to low flying species. If off-road deployment is required, the action could potentially impact habitat and result in indirect injury/mortality. If external generators are used, noise disturbance could potentially impact migratory patterns of wildlife. Refer to Section 2.4, Radio Frequency Emissions,

for more information on radio frequency concerns. Although unlikely, deployment of drones, balloons, blimps, or piloted aircraft could potentially impact wildlife by direct or indirect injury/mortality from entanglement, collision, or ingestion and potential effects to migratory patterns and reproductive effects from disturbance and/or displacement. The magnitude of these effects depends on the timing and frequency of deployments. However, deployment activities are expected to be temporary, likely affecting only a small number of wildlife. Potential impacts to wildlife could be further reduced by implementation of BMPs and mitigation measures (described in Chapter 11, BMPs and Mitigation Measures).

In general, the abovementioned activities could potentially involve land/vegetation clearing; excavation and trenching; construction of access roads; installation or restructuring of towers and poles; installation of underwater cables in limited near-shore or inland bodies of water; installation of security/safety lighting and fencing; and deployment of aerial platforms. Potential impacts to wildlife resources associated with deployment of this infrastructure could include direct injury/mortality, habitat loss, indirect injury/mortality, effects to migration, reproductive effects, and effects of invasive species depending on the ecoregion, the species' phenology, and the nature and extent of the habitats affected. These potential impacts and are described further below.

Given the scope of the Proposed Action, while geographically enormous (in all 50 states, 5 territories, and the District of Columbia), the actual deployment in any one location is unlikely to be extensive and would likely involve a variety of deployment options (including an emphasis on collocations on existing facilities). The specific deployment activity and location could be determined based on location-specific conditions and the results of site-specific environmental reviews and consultation with local, commonwealth, and federal agencies. These potential impacts associated with the Preferred Alternative, based on the deployment activity and the limited duration of construction activities, are described further below. BMPs and mitigation measures that could help to mitigate or reduce these potential impacts are described in Chapter 11, BMPs and Mitigation Measures.

Potential Impacts to Amphibians and Reptiles

Based on the analysis of the deployment activities described above to wildlife resources, potential impacts to Puerto Rico's amphibians and reptiles are anticipated to be *less than significant* at the programmatic level due to the localized and short term nature of these types of effects. See Chapter 11, BMPs and Mitigation Measures, for a listing of BMPs and mitigation measures that FirstNet and/or their partners would require, as practicable or feasible, to help avoid or minimize potential impacts associated with wildlife.

Potential Impacts to Terrestrial Mammals

Based on the analysis of proposed activities described above to wildlife resources, potential impacts to Puerto Rico's terrestrial mammals are anticipated to be *less than significant* at the programmatic level as deployment activities would be temporary and short in duration. See Chapter 11, BMPs and Mitigation Measures, for a listing of BMPs and mitigation measures that FirstNet and/or their partners would require, as practicable or feasible, to help avoid or minimize potential impacts associated with wildlife.

Potential Impacts to Marine Mammals

Based on the analysis of proposed activities described above to wildlife resources, potential impacts to Puerto Rico's marine mammals are anticipated to be *less than significant* at the programmatic level as deployment activities would be temporary, short in duration, take place in near-shore and inland waters and not the open ocean, and avoid important habitat areas. See Chapter 11, BMPs and Mitigation Measures, for a listing of BMPs and mitigation measures that FirstNet and/or their partners would require, as practicable or feasible, to help avoid or minimize potential impacts associated with wildlife.

Potential Impacts to Birds

Based on the analysis of proposed activities described above to wildlife resources, potential impacts to Puerto Rico's birds are anticipated to be *less than significant* at the programmatic level (see below for potential impacts, including potential RF exposure and tower impacts, during operations). BMPs and mitigation measures would be required, as practicable or feasible, to further reduce potential impacts to migratory birds. See Chapter 11, BMPs and Mitigation Measures, for a listing of BMPs and mitigation measures that FirstNet and/or their partners would require, as practicable or feasible, to help avoid or minimize potential impacts associated with wildlife.

Potential Impacts to Terrestrial Invertebrates

Potential impacts to Puerto Rico's terrestrial invertebrates are expected to be *less than significant* at the programmatic level. Some limited and localized impacts could result from Preferred Alternative effects such as habitat loss or invasive species. However, deployment activities are expected to be temporary, likely affecting only a small number of wildlife. See Chapter 11, BMPs and Mitigation Measures, for a listing of BMPs and mitigation measures that FirstNet and/or their partners would require, as practicable or feasible, to help avoid or minimize potential impacts associated with wildlife.

Potential Operation Impacts

As described in Section 2.1.2, Proposed Action Infrastructure, operation activities associated with the Preferred Alternative would consist of routine maintenance and inspection of the facilities. Any major infrastructure replacement as part of ongoing system maintenance would result in potential impacts similar to the abovementioned potential deployment impacts. The wildlife that would be affected would depend on the ecoregion, the species' phenology, and the nature and extent of the habitats affected.

It is anticipated that there would be *less than significant* impacts to wildlife resources at the programmatic level associated with routine inspections of the Preferred Alternative, assuming that the same access roads used for deployment are also used for inspections. Site maintenance would be infrequent, including mowing or the limited use of herbicides. This could result in *less than significant* effects to wildlife at the programmatic level including direct injury/mortality to less mobile wildlife, as well as injury/mortality from exposure to contaminants from accidental spills from maintenance equipment or release of pesticides. Light, odors, and noise associated with maintenance activities can delay or discourage bats from emergence, or potentially, cause site abandonment, but the infrequent and limited nature of the activity would also result in *less than significant* effects.

During operations, direct injury/mortality of wildlife could occur from collisions and/or entanglements with lines, poles, and aerial platforms. In particular, collisions with new cell towers that may be installed as part of the Preferred Alternative could increase avian mortality. As stated above, these impacts would likely be limited to individual wildlife species.
U.S. Department of Interior comments dated October 11, 2016, state communication towers are "currently estimated to kill between four and five million birds per year."[10] Although collisions with towers have the potential to impact a large number of birds unless BMPs and mitigation measures are incorporated, tower collisions are unlikely to cause population-level impacts.[11] Of particular concern is avian mortality due to collisions with towers at night, when birds can be attracted to tower obstruction lights. Research has shown that birds are attracted to steady, non-flashing red lights and are much less attracted to flashing lights, which can reduce migratory bird collisions by as much as 70 percent. The Federal Aviation Administration has issued requirements to eliminate steady-burning flashing obstruction lights and use only flashing obstruction lights (*FAA 2016a; FAA 2016b; FCC 2017*). See Chapter 11, BMPs and Mitigation Measures, for BMPs and mitigation measures that FirstNet and/or their partners would require, as practicable or feasible, to further avoid or minimize potential impacts to birds from tower lighting.

Wildlife resources could be affected by the reduction in habitat quality associated with habitat fragmentation from the presence of access roads, transmission corridors, and support facilities.

[10] See Chapter 14, Draft PEIS Public Comments, for the full text of the Department of Interior comments.

[11] The Migratory Bird Treaty Act protects individual birds, not just populations. Some species protected by the Endangered Species Act may potentially collide with towers. When considering a cumulative effects analysis, many poorly sited towers could potentially cause population-level impacts to rare species.

As stated above, these impacts would likely result in potential impacts to individuals rather than population-level impacts.

In addition, the presence of new access roads and ROWs could increase human use of the surrounding areas, which could increase disturbance to wildlife resulting in effects to migratory pathways, indirect injury/mortalities, reproductive effects, as well as the potential introduction and spread of invasive species as explained above. As stated above, these impacts would likely result in potential impacts to individuals rather than population-level impacts.

As summarized in Section 2.4, Radio Frequency Emissions, and earlier in this section, research indicates that RF exposure and collisions with towers may adversely affect birds and bats, although a distinct causal relationship between RF exposure and responses in birds or other wild animal populations has not been established. Targeted field research needs to be conducted to more fully document the nature and extent of effects of RF exposure on birds and bats, and the implications of those effects on populations over the long term. Implementation of BMPs and mitigation measures such as siting towers away from high bird use and communal bat use areas to the extent practicable and feasible (described in Chapter 11, BMPs and Mitigation Measures) could help minimize the potential for RF-related, as well as collision-related, impacts on birds and other wildlife. While these impacts could occur, they are expected to be limited in magnitude and extent, primarily affecting individuals in isolated occurrences. As such, potential operational impacts are expected to be *less than significant* at the programmatic level to Puerto Rico's wildlife resources except for bats and birds, which are expected to be *less than significant with BMPs and mitigation measures incorporated*. See Chapter 11, BMPs and Mitigation Measures, for a listing of BMPs and mitigation measures that FirstNet and/or their partners would require, as practicable or feasible, to help avoid or minimize potential impacts associated with wildlife.

Alternatives Impact Assessment

The following section assesses potential impacts to wildlife resources associated with the Deployable Technologies Alternative and the No Action Alternative.[12]

Deployable Technologies Alternative

Under the Deployable Technologies Alternative option, a nationwide fleet of mobile communications systems would provide temporary coverage in areas not covered by the existing, usable infrastructure. There would be no collocation of equipment and no new construction associated with wired or wireless projects discussed above under the Preferred Alternative. Some limited construction could be associated with implementation such as land clearing or paving for parking or staging areas. The specific infrastructure associated with the Deployable Technologies Alternative would be the same as the deployable technologies implemented as part of the Preferred Alternative but would likely be implemented in greater numbers, over a larger

[12] As mentioned above and in Section 2.1.2, Proposed Action Infrastructure, the Preferred Alternative includes implementation of deployable technologies.

geographic extent, and used with greater frequency and duration. Therefore, potential impacts to wildlife resources as a result of implementation of this alternative could be as described below.

Potential Deployment Impacts

Activities associated with the set up and operation of deployable technologies for short time periods could result in *less than significant* impacts at the programmatic level from direct and indirect injury or mortality events, changes in migratory patterns, disturbance, or displacement. Similar to potential impacts from the deployable elements of the Preferred Alternative, potential impacts under the Deployable Technologies Alternative could include potential noise or visual disturbances from aerial deployable equipment as well as bird strike hazards to low flying species; potential direct injury/mortalities to wildlife on roadways; potential habitat impacts and indirect injury/mortality from off-road deployment; and potential impacts to migratory wildlife patterns due to noise from external generators. Greater frequency and duration of deployments could change the magnitude of potential impacts depending on species, life history, and region of the territory. However, deployment activities are expected to be temporary, likely affecting only a small number of wildlife. Potential impacts associated with the Deployable Technologies Alternative could be further reduced if the BMPs and mitigation measures described in Chapter 11 are implemented.

Potential Operational Impacts

As explained above, operation activities would consist of implementation/running of the deployable technology and routine maintenance and inspections. As with the Preferred Alternative, it is anticipated that there would be *less than significant* impacts to wildlife resources at the programmatic level associated with routine operations, management, and monitoring. To further reduce potential impacts, the BMPs and mitigation measures described in Chapter 11 would be implemented. The potential impacts can vary greatly among species and geographic region and depend on the length and type of operation; potential impacts could result in indirect injury mortality or reproductive effects.

No Action Alternative

Under the No Action Alternative, the NPSBN would not be deployed; therefore there would be no associated construction or installation of wired, wireless, deployable infrastructure or satellites and other technologies. As a result, there would be *no impacts* to wildlife resources because there would be no deployment or operation of the Proposed Action. Environmental conditions would therefore be the same as those described in Section 8.1.6.4, Wildlife.

8.2.6.5. Fisheries and Aquatic Habitats

Introduction

This section describes potential impacts to fisheries resources in Puerto Rico associated with deployment and operation of the Proposed Action. Mitigation measures, as defined through permitting and/or consultation with the appropriate resource agency, would be implemented as part of deployment and operation of the Proposed Action to help avoid or reduce potential impacts to fisheries resources. Implementation of best management practices (BMPs), as practicable or feasible, could further reduce the potential for impacts. Both mitigation measures and BMPs are discussed in Chapter 11, BMPs and Mitigation Measures.

Impact Assessment Methodology and Significance Criteria

The potential impacts of the Proposed Action on fisheries resources were evaluated using the significance criteria presented in Table 8.2.6.2-1. As described in Section 8.2, Environmental Consequences, the categories of impacts are defined at the programmatic level as *potentially significant*, *less than significant with BMPs and mitigation measures incorporated*, *less than significant*, or *no impact*. Characteristics of each impact type, including magnitude or intensity, geographic extent, and duration or frequency, were used to determine the impact significance rating associated with each potential impact.

Given the nature of this programmatic evaluation, and because the Proposed Action could potentially cover a wide variety of actions that would take place in various landscapes, the potential impacts to fisheries resources addressed in this section are presented as a range of possible impacts.

Description of Environmental Concerns

Direct Injury/Mortality

Direct injury/mortality effects are physical injuries, extreme physiological stress, or death of an individual organism from that could result interactions associated with the Proposed Action. The most common direct injuries from equipment deployment and operation events are entanglement, habitat degradation, accidental ingestion of marine debris, and disturbance incurred by sensitive tropical fishes. However, given that the Proposed Action is only envisioned to be deployed in limited near-shore and inland waters, it is unlikely to impact large populations of fish and any potential impacts would likely be localized, isolated, short-term, and limited to individual or small numbers of fish.

Indirect injury/mortality environmental concerns pertaining to Puerto Rico’s fisheries are described below.

Coral Reefs and Seagrasses, Habitat Loss, Degradation, or Fragmentation

Puerto Rico provides highly productive coral habitats, submerged vegetation (i.e., seagrasses), wetlands, rivers, and complex hardbottom substrates harboring many marine fishes, invertebrates, mollusks, colonization and other aquatic organisms and related activities (*CFMC 2015*). NOAA and the regional fishery management councils have identified more than 100 habitat areas of particular concern in Puerto Rico. These are considered high priority areas for conservation, management, or research because they are rare, sensitive, easily stressed by development, or important to ecosystem function (*CFMC 2015*). Corals and seagrasses form both the trophic[1] and structural foundation that marine fisheries are dependent upon. Many environmental concerns arise with the clearing of habitat; however, as the proposed deployment activities are only envisioned to be performed in limited near-shore and inland waters, it is unlikely that deployment would result in impacts to coral reefs or seagrasses. Implementation of BMPs and mitigation measures could help further reduce potential impacts.

Coral reefs provide habitat, spawning, and nursery grounds for half of all federally managed fisheries as well many subsistence, recreational, and aquaculture fish species important to Puerto Rico (*CFMC 2014; NOAA 2015b*). Global concerns affecting corals include disease, ocean acidification affecting coral calcium carbonate skeletons, coral bleaching,[2] and increasing amounts of carbon dioxide in ocean water because of human development. Although it is unlikely the Proposed Action could contribute to these impacts, it is worth noting that the combination of these threats could inadvertently lead to high mortality of diverse resident and migratory fishes found in and around Puerto Rico.

Habitat loss occurring through direct or indirect exclusion, either by physically preventing organisms from using a habitat or by causing fish to avoid a habitat, could potentially lead to temporary or long-term effects. Habitat exclusion could lead to the prevention of fish and invertebrates (e.g., shellfish, sea cucumbers) from accessing an optimal habitat for breeding, spawning, feeding, or cover. Coral reefs, seagrass meadows, and mangrove prop roots are all important habitats that support fish and would likely be avoided to the extent practicable or feasible. These productive zones provide food, shelter, and nursery areas for fish at various stages of their lives. Specific examples of fishes displaced from habitat in Puerto Rico include the American eel (*Anguilla rostrate*), river goby (*Awaous banana*), parrotfish (family Scaridae), guavina (*Guavina* spp.), and the spinycheek sleeper (*Eleotris* spp.). All of these species have been impacted by habitat loss, pollution, and reductions in population and range (*PRDNER 2005*). Although the Proposed Action activities are unlikely to occur near reefs, if deployment is proposed to occur near reefs then FirstNet and/or their partners should refer to the Reef Fish Fishery Management Plans of Puerto Rico prior to construction (*CFMC 1985*).

Three types of mangroves, including red mangroves (*Rhizophora mangle*), black mangroves (*Avicennia germinans*), and white mangroves and buttonwood (*Laguncularia racemose* and *Conocarpus erectus*), line the shorelines of Puerto Rico (*Elenas 2013*). Mangrove wetland systems maintain coastal waters and marine organisms by protecting water quality, providing fishery habitat, and reducing flood damage. Actions that can alter habitat or create physical barriers during equipment placement and operation should be avoided to the extent practicable to

[1] Trophic involves the feeding habits or relationships of different organisms in a food chain or food web (*NOAA 2006*).
[2] Coral bleaching is the stress response of corals releases the photosynthetic plankton, known as Zooxanthellae, leading to coral bleaching (*NOAA 2006*).

help minimize impacts associated with access to suitable habitat. Additional BMPs and mitigation measures to help avoid wetland degradation[3] are discussed in Chapter 11, BMPs and Mitigation Measures. The Department of Natural and Environmental Resources of Puerto Rico is responsible for the management of marine protected areas, natural reserves and marine managed areas (*USMPA 2015*). These areas, which provide critical habitat and essential fish habitat, include coral reefs, seagrass meadows, lagoons, mangroves, estuaries, wetlands, offshore keys, sandy beaches, and rocky shores (*USMPA 2015*). Avoidance of critical habitat and refuges within Puerto Rico could help prevent anthropogenic disturbance on these fishery resources from the Proposed Action.

Disturbance to sea floor habitats could cause fishery-related stresses such as direct injury or mortality, loss of refuge or cover habitat, increase of suspended sediment, and disturbance or mortality of fish prey (e.g., algae, invertebrates). Land-based sediment and erosion can cause mortality in fish given the water clarity required by coral reef systems (*Rogers 1990*). Installation and operation on or near sea floor and limited near-shore and inland habitats can alter productivity and reduce survivorship by increased sedimentation and turbidity reaching nearby waterways utilized during fish passage. Fragmentation from construction and development can present major environmental concerns including the loss of resident fish species and range reductions (*Pacific Fishery Management Council 2015*). These potential impacts could also extend to many invertebrate and fish assemblages associated with habitat. However, as the Proposed Action is only envisioned to be deployed in limited near-shore and inland waters, it is unlikely to impact large populations of fish and potential impacts would likely be limited to individual or small numbers of fish. Sediment and erosion control would be implemented in accordance with federal, commonwealth, or local regulations. BMPs and mitigation measures would be required, as practicable or feasible, to help further reduce potential sedimentation and turbidity (see Chapter 11, BMPs and Mitigation Measures).

Indirect Injury/Mortality

Indirect injury to aquatic habitat (e.g., coral reefs and seagrasses) that inadvertently affect fisheries includes changes in water quality, pH, and increased water turbidity (*USGS 2014*). Indirect injuries to individuals could be caused by underwater sound, poor water quality, or changes in food availability. Depending on magnitude and frequency, underwater sound made during operation and deployment of equipment, such as noise created by motor boats laying cable or heavy equipment near the shoreline, can physically damage aquatic organisms or disrupt movement and migration patterns (*USDOT 2011*). BMPs and mitigation measures to help reduce the effects of underwater noise are addressed in Chapter 11, BMPs and Mitigation Measures. Indirect mortality and exclusion from resources could also result from degraded water quality or perturbation of physical habitat features. However, as deployment activities would likely be temporary and of short duration, it is anticipated that any impacts would be limited to individual fish and aquatic organisms.

[3] See Section 8.2.5, Wetlands, for more information related to potential impacts to wetlands.

Potential indirect fisheries impacts associated with construction noise, installation, and increased human activity could include abandoned reproductive efforts, displacement, and avoidance of work areas, though these potential impacts would likely be temporary. Both direct and indirect potential impacts on fish and other marine life are expected to be short in duration and infrequent (limited to the period of activities). Mortality and injury of individual fish and aquatic organisms directly or indirectly linked to Proposed Action activities would likely be infrequent and could be further minimized by maintaining access to habitats and avoiding critical, species-specific time periods (e.g., spawning and migration).

Effects to Migration or Migratory Patterns

In marine systems, highly migratory species are characterized as having vast geographical distributions with single stocks utilizing both national and international waters for feeding or reproduction (*Pacific Fishery Management Council 2015*). Highly migratory species identified in the Magnuson-Stevens Act include tuna species, marlin (*Tetrapturus* spp. and *Makaira* spp.), oceanic sharks, sailfishes (*Istiophorus* spp.), and swordfish (*Xiphias gladius*) (*NOAA 2007b*).

Fish produce sounds through three ways: drumming of the swim bladder with the sonic muscle, striking or rubbing together teeth or skeletal parts, and hydrodynamic sound production when fish quickly change speed and direction. The majority of sounds produced by fishes are of low frequency, typically less than 1000 Hz.

Many statutes and regulations have been implemented in Puerto Rico to minimize project activities on specific migratory fish-bearing waterbodies and are discussed in Section 8.1.6.5, Fisheries and Aquatic Habitats. Strict regulations also apply to migratory/anadromous[4] fish of Puerto Rico (*NOAA 2015a*). It is possible that the Proposed Action could potentially impact migration or migratory patterns as a result of construction or if the duration of operation deterred use of suitable habitat by fish, invertebrates, crustaceans, etc. However, it is anticipated that any interruption of migratory patterns would be minimal, or not likely to occur within the Proposed Action area. Areas used by migratory fish tend to be isolated within migration pathways, spawning grounds, rearing sites, and nursery areas of resident and anadromous fish.

Proposed Action related noise could mask communications by aquatic species and displace them entirely. Researchers have found that when fish are exposed to high noise levels, communication and auditory sensitivity were found to decline (*Ladich 2013; Codarin et al. 2009*). If continuous high levels of ambient noise persist in an area (e.g., from existing pedestrian traffic, highway noise, and other human activities in the area), the additional noise from installation, deployment, and operation could be negligible and species could acclimate. Otherwise, some species could

[4] Anadromous fish are born in freshwater, migrate to the ocean to grow as adults, and then return to freshwater to spawn (*NOAA 2006*).

become temporarily or permanently displaced due to noise. Physical noise displacement from the Proposed Action could cause fish and marine organisms to use an excess expenditure of energy, to avoid the noise source or search for more suitable habitat. This, in turn, depletes energy reserves normally used for growth, migration, and/or reproduction. It is possible that the Proposed Action could impact migratory patterns due to noise, but it is likely that such impacts would be very localized (associated with limited near-shore and inland water deployment) and of a short duration. Therefore, it is anticipated that migratory patterns would be subject to minimal noise disturbance during construction and operation. Additionally, to further reduce potential impacts, suitable habitat availability in the vicinity of the Proposed Action could be considered to accommodate these species to the extent practicable. For specific noise BMPs and mitigation measures, see Chapter 11, BMPs and Mitigation Measures.

Reproductive Effects

The Magnuson-Stevens Fishery Conservation and Management Act (*16 USC § 1801 et seq.*) established a management system for fishery resources in the United States. Identification of essential fish habitat includes "those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity" (*NOAA 2007a*).

Potential impacts to functional development of life stages (i.e., eggs and larvae), could be reduced by minimizing physical barriers. One example of temporary or long-term barriers is the underwater housing of cables that could potentially prevent the success of fish egg fertilization or invertebrate passage during construction or operation, although unlikely due to the small size of underwater conduit that contain telecommunication cable While even more unlikely, disruption of fish passage could also influence reproductive timing and larval traits that are indicative of the biological connectivity throughout Puerto Rico and neighboring islands (*CFMC 2014*). Reproductive effects to fish and shellfish species are most prevalent through the direct loss of spawning habitat, slow recovery rates of habitat features, and the mortality of eggs and juveniles. However, the Proposed Action anticipates only minor disruption of the reproduction of fisheries and disturbance of their resources as individual projects would be small scale (generally less than an acre of disturbance) and deployment would be short term.

During construction, activities such as minor removal of aquatic and terrestrial vegetation, in-stream trenching, and equipment installation could potentially result in the modification of aquatic habitats and thereby adversely affect fish reproduction. Other risks of vegetation clearing and soil compaction could potentially lead to an increase of runoff into coastal habitats (*Thrush et al. 2004*). Potential impacts could include increased sedimentation and turbidity (see Section 8.2.2, Soils), increased temperature, decreased dissolved oxygen concentrations, releases of existing chemical and nutrient pollutants from disturbed sediments, and introduction of chemical contaminants, such as fuel and lubricants, due to spills (see Section 8.2.4, Water Resources). However, due to the scale of the individual projects (generally less than an acre of disturbance) and the short duration of deployment activities (in some cases, as little as a few hours at one location) it is unlikely that deployment activities would result in more than minor impacts to fish from removal of vegetation or increased sedimentation. Additionally all federal, commonwealth, and local regulatory requirements would be adhered to regarding erosion and sediment control. BMPs and mitigation measures would be implemented to help further prevent sedimentation and other discussed hazards from reaching nearby surface waters (see Chapter 11, BMPs and Mitigation Measures). Measures such as time or area restrictions, avoidance of certain habitats, and mitigation could minimize adverse effects on reproductive habitat.

Invasive Species Effects

The introduction of nonnative species affects the structure and function of aquatic systems relied upon by fish. Invasive species can diminish the health of native fish communities through predation, disease introduction, habitat alteration, and competition for resources (e.g., food and space) (*USFWS 2012*). For example, the invasive Indo-Pacific lionfish has been documented on Puerto Rico. Many efforts and management plans have been established to physically remove this species. In 2010, Puerto Rico created a "Special Disposition for the Lionfish" under fish regulations to encourage public outreach and the eradication of this species (*Morris 2012*). It is, however, unlikely that the Proposed Action would result in dispersal of lionfish.

It is possible that the Proposed Action could potentially impact native species if previously deployed equipment is not cleaned and sterilized to prevent the spread of invasive algae, fish species, or other aquatic organisms. However, it is anticipated that the small scale of the individual projects (generally less than an acre) and the short duration of deployment activities would be unlikely to result in the spread of invasive species. Additionally, implementation of BMPs and mitigation measures (and recommended sanitation procedures) could help further prevent the spread of invasive species and the alteration of fishery habitat.

Potential Impacts of the Preferred Alternative

The following section assesses potential impacts associated with implementation of the Preferred Alternative, including construction/deployment and operation activities.

Potential Deployment Impacts

As described in Section 2.1.2, Proposed Action Infrastructure, implementation of the Preferred Alternative would result in the deployment of various types of facilities or infrastructure. Depending on the physical nature and location of the facility/infrastructure and the specific deployment requirements, some activities would result in potential impacts to fisheries resources and others would not. In addition, and as explained in this section, the various types of Preferred Alternative infrastructure could result in a range of *no impacts* to *less than significant* impacts at the programmatic level depending on the deployment scenario or site-specific conditions. Site-specific analysis may be required depending on the site conditions, the type of deployment, or any other permits or permissions necessary to perform the work.

<u>Activities Likely to Have No Impacts</u>

Of the types of facilities or infrastructure development scenarios described in Section 2.1.2, Proposed Action Infrastructure, the following are likely to have *no impacts* to fisheries resources at the programmatic level under the conditions described below:

- Wired Projects
  - Use of Existing Conduit–New Buried Fiber Optic Plant: Disturbance associated with the installation of fiber optic cable in existing conduit would be limited to entry and exit points of the existing conduit in previously disturbed areas. It is anticipated that there would be *no impacts* to fisheries resources at the programmatic level since the activities that would be conducted at these small entry and exit points are not likely to produce perceptible changes and are likely not located in, or affect, fish habitat. Implementing BMPs and mitigation measures (see Chapter 11, BMPs and Mitigation Measures) could help further reduce these potential impacts.
  - Use of Existing Buried or Aerial Fiber Optic Plant or Existing Submarine Cable: Lighting up of dark fiber would have no impacts to fishery resources because there would be no ground or aquatic habitat disturbance.
- Satellites and Other Technologies
  - Satellite-Enabled Devices and Equipment: It is anticipated that the installation of permanent equipment on existing structures and the use of portable devices that use satellite technology would not impact fisheries resources because those activities would not require ground or waters disturbance.
  - Deployment of Satellites: FirstNet does not anticipate launching satellites as part of the deployment of the nationwide public safety broadband network (NPSBN); however, it could include equipment on satellites that are already being launched for other purposes. As adding equipment to an existing launch vehicle would be very unlikely to impact fisheries resources, it is anticipated that this activity would have *no impact* to those resources.

Activities with the Potential to Have Impacts

Potential construction/deployment-related impacts to fisheries resources as a result of implementation of the Preferred Alternative would encompass a range of potential impacts that could occur as a result of ground or water disturbing activities, including plowing, trenching, boring, and filling in fish habitat. The types of infrastructure development scenarios or deployment activities that could be part of the Preferred Alternative and result in potential impacts to fisheries resources include the following:

- Wired Projects
  - New Build–Buried Fiber Optic Plant: Plowing (including vibratory plowing), trenching, excavating, filling, directional boring and the construction of points of presence,[5] including huts or other associated facilities or hand-holes to access fiber, could result in potential impacts to fisheries and fish habitat. Although potential impacts are usually temporary, buried fiber optic installation methods could potentially result in high-risk situations to fisheries resources by sedimentation from on-shore activities. Furthermore,

[5] Points of Presence are connections or access points between two different networks, or different components of one network.

these risks include the removal of productive habitat, blocked passage of streams used by anadromous fish during reproduction periods, and the introduction of excess sediment and turbidity into waterways during construction/deployment. Ground and water disturbance associated with vibratory plowing activities and excavation activities could also result in fish habitat loss and mortality of individuals due to ground-born sound transmissions. Sound pressure waves pass through various media (soil, water, air) and can propagate long distances with little attenuation, especially when travelling through water (*Dahl et al. 2007*). Aquatic organisms' sensitivity to sound and vibrations varies greatly by species, with sharks and bony fish being particularly sensitive (*University of Maryland 2000*), thus sound and pressure waves can change fish behavior (*Popper and Hastings 2009*). Egg viability and embryoic development of aquatic species can be affected when exposed to low frequency vibrations (*VanDerwalker 1964; Vandenberg et al. 2012*). It is anticipated that these potential impacts would be minimal due to the small footprint of deployment activities (generally less than an acre), the short duration of those activities, and the application of federal, commonwealth, or locally required sediment and erosion control mechanisms.

- New Build–Aerial Fiber Optic Plant: Ground and water disturbance and heavy equipment use associated with construction activities as well as land/vegetation clearing, and excavation activities associated with pole construction could result in fish habitat loss if activities occur near/in lakes, streams, rivers, coastlines, or wetlands. Noise and sedimentation associated with construction activities could stress fish, therefore potentially impacting their longevity and/or migratory patterns. It is anticipated that these potential impacts would be minimal due to the small footprint of deployment activities (generally less than an acre), the short duration of those activities, and the application of federal, commonwealth, or locally required sediment and erosion control mechanisms.
- Collocation on Existing Aerial Fiber Optic Plant: Installation of cables using existing poles and structural hardening or reinforcement of equipment to improve disaster resistance and resiliency would have few potential impacts on fisheries habitat compared to new build construction, although some fish habitat loss could occur if activities were near/in lakes, streams, rivers, coastlines, or wetlands. It is anticipated that these potential impacts would be minimal due to the small footprint of deployment activities (generally less than an acre), the short duration of those activities, and the application of federal, commonwealth, or locally required sediment and erosion control mechanisms. Implementing BMPs and mitigation measures (see Chapter 11, BMPs and Mitigation Measures) could help further reduce these potential impacts.
- New Build–Submarine Fiber Optic Plant: The installation and construction of sealed cables in limited near-shore or inland bodies of water and the construction of landings/facilities on the shore to accept cable buried close to the shoreline could potentially impact fisheries resources. Although sensitive or vulnerable areas vary along Puerto Rico's shores, changes to aquatic communities that occupy the shoreline could

disrupt fish development, sessile[6] invertebrates, alter community structure, and potentially change the fishery dynamics within the aquatic habitat (*NOAA 2008*). It is anticipated that these potential impacts would be minimal due to the small footprint of deployment activities (generally less than an acre), the short duration of those activities, and the application of federal, commonwealth, or locally required sediment and erosion control mechanisms. Implementing BMPs and mitigation measures (see Chapter 11, BMPs and Mitigation Measures) could help further reduce these potential impacts.

- Installation of Optical Transmission or Centralized Transmission Equipment: If installation of transmission equipment would occur in existing boxes or huts and require no ground or water disturbance, there would be *no impacts* to fisheries. Ground and water disturbance during the installation of equipment to enhance the signals traveling through the fiber may involve the installation of concrete pads and potential construction of an access road, potentially leading to runoff, erosion, and sediment reaching nearby fishery habitats. These construction activities, which may include land/vegetation clearing and excavation, could potentially result in the loss of fishery habitat. If an access road is constructed, additional potential impacts to fish habitat resulting from stream crossing methods, culvert installations, and road runoff should be considered. It is anticipated that these potential impacts would be minimal due to the small footprint of deployment activities (generally less than an acre), the short duration of those activities, and the application of federal, commonwealth, or locally required sediment and erosion control mechanisms. Implementing BMPs and mitigation measures (see Chapter 11, BMPs and Mitigation Measures) could help further reduce these potential impacts.

- Wireless Projects
  - New Wireless Communication Towers: Installation of new wireless towers and associated structures (generators, equipment sheds, fencing, security and aviation lighting, electrical feeds, and concrete foundations and pads) or access roads constructed near aquatic habitats could potentially result in potential impacts to fish habitat and other fisheries resources (i.e., construction noise disturbance, light pollution, and spills from generator fluids). It is anticipated that these potential impacts would be minimal due to the small footprint of deployment activities (generally less than an acre) and the short duration of those activities. Implementing BMPs and mitigation measures (see Chapter 11, BMPs and Mitigation Measures) could help further reduce these potential impacts.
  - Collocation on Existing Wireless Tower, Structure, or Building: Collocation would involve mounting or installing equipment (such as antennas or microwave dishes) on an existing tower and would result in less potential impact to fisheries than the construction of new wireless communication towers. However, if the onsite delivery of additional power units, structural hardening, and physical security measures were required,

[6] Sessile invertebrates are unable to move, attached to the substrate (*NOAA 2006*).

temporary potential impacts and disturbance to fishery habitat, although unlikely, could potentially lead to species deterrence and loss of suitable habitat.

- Deployable Technologies
  - Where deployable technologies (i.e., Cell on Wheels, Cell on Light Truck, System on Wheels, or aerial deployables such as piloted aircraft, balloons, or drones) would be implemented on existing paved and unpaved road surfaces, it is anticipated that there would be *no impacts* to fisheries resources because there would be no new ground or water disturbance. However, implementation of deployable technologies could result in potential impacts to fisheries resources if deployment occurs in off-road areas. Some construction of staging or landing areas (depending on the type of technology) may require land/vegetation clearing, excavation, and paving. Although unlikely, these activities could result in loss of fish habitat (e.g., wetlands, streams, or vegetation used as cover in these areas). In addition, while likely to only impact individual fish, implementation of aerial deployable technologies could result in direct injury or death to fish or damage to fish habitat if a piece of equipment were to fall into an aquatic habitat. To retrieve a fallen piece of equipment, additional fish habitat damage could occur. It is anticipated that these potential impacts would be minimal due to the small footprint of deployment activities (generally less than an acre) and the short duration of those activities (as short as a few hours in some cases). Implementing BMPs and mitigation measures (see Chapter 11, BMPs and Mitigation Measures) could help further reduce these potential impacts.

In general, the abovementioned activities could potentially involve ground, water, and near-shore sea floor disturbance by heavy equipment use associated with the construction activities, land/vegetation clearing, and excavation activities associated with construction. Potential impacts to fisheries resources associated with deployment of this infrastructure could include direct injury/mortality, habitat loss, indirect injury/mortality, effects to migration, reproductive effects, and introduction of invasive species.

Given the scope of the project, while geographically enormous (50 states, 5 territories, and the District of Columbia), the actual deployment in any one location is unlikely to be extensive (generally less than an acre) and would likely involve a variety of deployment options (including an emphasis on collocations on existing facilities). The specific deployment activity, and where the deployment would take place, would be determined based on location-specific conditions. Site-specific analysis may be required depending on the site conditions, the type of deployment, or any other permits or permissions necessary to perform the work. These potential impacts associated with the Preferred Alternative, based on the deployment activity and the limited duration of construction activities, are described further below. BMPs and mitigation measures that could help mitigate or reduce these potential impacts are described in Chapter 11, BMPs and Mitigation Measures.

Potential Direct Injury/Mortality Impacts

Based on the analysis of the deployment activities described above to fisheries resources, potential impacts as a result of direct injury/mortality are anticipated to be *less than significant* at the programmatic level since the proposed activities are only envisioned to be deployed in limited near-shore and inland waters, are unlikely to impact large populations of fish, and any potential impacts would likely be localized, isolated, short-term, and limited to individual or small numbers of fish. See Chapter 11, BMPs and Mitigation Measures, for a listing of BMPs and mitigation measures that FirstNet and/or their partners would require, as practicable or feasible, to help avoid or minimize potential impacts associated with fisheries and aquatic habitats.

Potential Habitat Loss Impacts

Based on the analysis of the potential deployment effects to fisheries resources described above, potential impacts as a result of habitat loss are anticipated to be *less than significant* at the programmatic level. It is anticipated that for most types of facilities or infrastructure development scenarios, loss of terrestrial vegetation would likely be isolated within construction locations and/or would be short-term with stability achieved within several years, depending on the vegetation cover present in the area. In addition, since the proposed deployment activities are only envisioned to be performed in limited near-shore and inland waters, it is unlikely that deployment would result in impacts to aquatic habitats. See Chapter 11, BMPs and Mitigation Measures, for a listing of BMPs and mitigation measures that FirstNet and/or their partners would require, as practicable or feasible, to help avoid or minimize potential impacts associated with fisheries and aquatic habitats.

Potential Indirect Injury/Mortality Impacts

Based on the analysis of the potential deployment effects to fisheries resources described above, potential impacts as a result of indirect injury/mortality are anticipated to be *less than significant* at the programmatic level since deployment activities would likely be temporary, of short duration, and any impacts would likely be limited to individual fish and aquatic organisms. See Chapter 11, BMPs and Mitigation Measures, for a listing of BMPs and mitigation measures that FirstNet and/or their partners would require, as practicable or feasible, to help avoid or minimize potential impacts associated with fisheries and aquatic habitats.

Potential Migration Impacts

Based on the analysis of the deployment activities described above to fisheries resources, potential migration impacts are anticipated to be *less than significant* at the programmatic level since such impacts are anticipated to be localized, short term, and limited to near-shore and inland environments. See Chapter 11, BMPs and Mitigation Measures, for a listing of BMPs and mitigation measures that FirstNet and/or their partners would require, as practicable or feasible, to help avoid or minimize potential impacts associated with fisheries and aquatic habitats.

Potential Reproductive Effects Impacts

Based on the analysis of the deployment activities described above to fisheries resources, potential impacts as a result of reproductive effects are anticipated to be *less than significant* at the programmatic level. It is anticipated that project activities would result in only minor disruption to fisheries reproduction at the individual level, not the population level. Potential impacts to reproduction would also likely be short term and localized. See Chapter 11, BMPs and Mitigation Measures, for a listing of BMPs and mitigation measures that FirstNet and/or their partners would require, as practicable or feasible, to help avoid or minimize potential impacts associated with fisheries and aquatic habitats.

Potential Invasive Species Impacts

Based on the analysis of the deployment activities described above to fisheries resources, potential invasive species impacts are anticipated to be *less than significant* at the programmatic level. It is anticipated that the small scale of the individual projects (generally less than an acre) and the short duration of deployment activities would be unlikely to result in the spread of invasive species. See Chapter 11, BMPs and Mitigation Measures, for a listing of BMPs and mitigation measures that FirstNet and/or their partners would require, as practicable or feasible, to help avoid or minimize potential impacts associated with fisheries and aquatic habitats.

Potential Operation Impacts

As described in Section 2.1.2, Proposed Action Infrastructure, operation activities associated with the Preferred Alternative would consist of routine maintenance and inspection of the facilities. Any major infrastructure replacement as part of ongoing system maintenance would likely result in potential impacts similar to the abovementioned potential deployment/ construction impacts. It is anticipated that there would be few potential impacts to fisheries resources associated with routine inspections of the Preferred Alternative, assuming that the same access roads used for deployment are also used for inspections. Although unlikely, limited use of herbicides and the potential release of other contaminants by runoff could present potential impacts to fish and their habitats. If usage of heavy equipment as part of routine maintenance or inspections occurs off of established access roads or corridors, additional potential fish impacts could occur (e.g., stream bank erosion, sedimentation of streams). However, these impacts would likely be localized, limited to individual species, and unlikely to cause population-level impacts. Additionally, it is anticipated that any maintenance activities would involve less physical disturbance than initial deployment, occur over a short period of time (as little as a few hours to several days depending on the nature of the maintenance or inspection activity), and would comply with any federal, commonwealth, or local sediment and erosion control requirements.

Alternatives Impact Assessment

The following section assesses potential impacts to fisheries associated with the Deployable Technologies Alternative and the No Action Alternative.[7]

Deployable Technologies Alternative

Under the Deployable Technologies Alternative, a nationwide fleet of mobile communications systems would provide temporary coverage in areas not covered by the existing, usable infrastructure. There would be no collocation of equipment and no new construction associated with wired or wireless projects discussed above under the Preferred Alternative. Some limited construction could be associated with implementation such as land clearing or paving for parking or staging areas. The specific infrastructure associated with the Deployable Technologies Alternative would be the same as the deployable technologies implemented as part of the Preferred Alternative but would likely be implemented in greater numbers, over a larger geographic extent, and used with greater frequency and duration. Therefore, potential impacts to fisheries resources as a result of implementation of this alternative could be as described below.

Potential Deployment Impacts

The implementation of deployable technologies is not anticipated to cause significant potential impacts to fisheries resources at the programmatic level. Deployment and operation of cellular masts and antenna generated signals are anticipated to have minimal disturbance to fish. However, greater frequency and duration of deployments could change the magnitude of potential impacts depending on species, life history, and region of the territory.

The main potential impact on fisheries would be the placement of deployable infrastructure near waterbodies. Generator stations that power this infrastructure are designed to be self-contained within a trailer. This would require fuel storage to be kept onsite with associated protection plans to prevent spills and contamination to fishery dependent waterways.

Tidal regimes, which may differ between the north and south coasts, should be taken into account when deploying equipment near coastal locations. This would prevent loss of equipment and marine debris in nearby coastal fish habitat.

Puerto Rico is a Caribbean island located in a tropical marine climate that experiences seasonal trade winds, ocean swells, and tropical storms. Routine maintenance checks of equipment operation sites could prevent potential impacts by equipment weathering, such as corrosion of metal, rust, and growth removal to reduce potential impacts on water quality and prevent coastal source pollution. Stability in the construction of equipment to withstand natural environmental factors, (e.g., storms, hurricanes, and typhoons) could prevent the irritation or damage to the digestive systems of fish (*NOAA 2011*).

[7] As mentioned above and in Section 2.1.2, Proposed Action Infrastructure, the Preferred Alternative includes implementation of deployable technologies.

Potential Operation Impacts

As explained above, operation activities would consist of running of the deployable technology and routine maintenance and inspections. As with the Preferred Alternative, it is anticipated that there would be *no impacts* to fisheries resources at the programmatic level associated with routine inspections of the Deployable Technologies Alternative, assuming that the same access roads used for deployment are also used for inspections. If routine maintenance or inspections occur off of established access roads or corridors, or if the acceptable load capacity of the roads is exceeded, sediment laden run-off and increased stream bank erosion could occur. The utilization of buffer zones, temporary or permanent native seeding on disturbed ground, ground cover, plastic sheeting and matting would minimize sedimentation of aquatic systems. In addition, Stormwater Pollution Prevention Plans are required at construction sites where more than 1 acre of ground would be disturbed (*USEPA 2007*).

Coastal development and expansion can cause potential impacts to aquatic organisms by underwater sound, poor water quality or changes in food availability. Underwater sound during equipment operation, depending on magnitude and frequency, can physically damage fish or disrupt movement and migration patterns (*Popper and Hastings 2009; USDOT 2011*). It is anticipated that underwater sound would be minimal as deployment of land-based equipment would not likely occur on the shoreline (due to instability and likelihood of damage from weather-related hazards). Aerial deployments would also only produce sound when flying and would not likely stay in one location very long.

To minimize disturbance for the duration of operation, which could potentially last up to 2 years, FirstNet and/or their partners would likely work to avoid productive habitats such as coastal wetlands, inland waterways, essential fish habitat, anadromous fish spawning areas, seagrasses, and reefs, to the extent practicable. Adverse effects on these productive habitats could include many potential direct and indirect impacts in the form of physical, chemical, or biological alterations of the waters or substrate and loss of, or injury to, individuals, fisheries, benthic organisms, prey species and their habitat, and many other ecosystem components (*NOAA 2007a*). However, it is anticipated that these potential impacts would be minimal due to the small footprint of deployment activities (generally less than an acre) and the short duration of those activities (as short as a few hours in some cases). Implementing BMPs and mitigation measures (see Chapter 11, BMPs and Mitigation Measures) could help further reduce these potential impacts.

No Action Alternative

Under the No Action Alternative, the NPSBN would not be deployed; therefore there would be no associated construction or installation of wired, wireless, deployable infrastructure or satellites and other technologies. As a result, there would be *no impacts* to fisheries resources as there would be no deployment or operation of the Proposed Action. Environmental conditions would therefore be the same as those described in Section 8.1.6.5, Fisheries and Aquatic Habitats.

8.2.6.6. Threatened and Endangered Species and Species of Conservation Concern

Introduction

This section describes potential impacts to federal- or territory-listed plant and animal species[1] (hereafter collectively referred to as listed species) and designated critical habitat associated with deployment and operation of the Proposed Action. Mitigation measures, as defined through permitting and/or consultation with the appropriate resource agency, would be implemented as part of deployment and operation of the Proposed Action to help avoid or reduce potential impacts to threatened and endangered species and species of conservation concern. Implementation of best management practices (BMPs), as practicable or feasible, could further reduce the potential for impacts. Both mitigation measures and BMPs are discussed in Chapter 11, BMPs and Mitigation Measures.

Impact Assessment Methodology and Significance Criteria

The potential impacts of the Proposed Action on listed species were evaluated using the significance criteria presented in Table 8.2.6.6-1. As described in Section 8.2, Environmental Consequences, the categories of impacts are defined at the programmatic level as: *may affect, likely to adversely affect; may affect, not likely to adversely affect;* and *no effect*. These impact categories are comparable to those defined in the *Endangered Species Consultation Handbook* and are described in general terms below (*USFWS and NMFS 1998*):

- *No effect* means that no listed resources would be exposed to the action and its environmental consequences.
- *May affect, not likely to adversely affect* means that all effects are beneficial, insignificant, or discountable. Beneficial effects have contemporaneous positive effects without any adverse effects to the species or habitat. Insignificant effects relate to the size of the impact and include those effects that are undetectable, not measurable, or cannot be evaluated. Discountable effects are those extremely unlikely to occur.
- *May affect, likely to adversely affect* means that listed resources are likely to be exposed to the action or its environmental consequences and would respond in a negative manner to the exposure.

Characteristics of each impact type, including magnitude or intensity, geographic extent, and duration or frequency, were used to determine the impact significance rating associated with each potential impact.

[1] These species include terrestrial, freshwater, and marine plant and animal species that are federally listed as threatened, endangered, candidate, proposed, or species of concern; species that are territory-listed as critically endangered, endangered, threatened, or vulnerable; and/or species that receive specific protection defined in federal or territorial legislation.

Table 8.2.6.6-1: Impact Significance Rating Criteria for Listed Species and Critical Habitats

Type of Effect	Effect Characteristic	Impact Level at the Programmatic Level		
		May Affect, Likely to Adversely Affect	**May Affect, Not Likely to Adversely Affect**	**No Effect**
Direct and Indirect Injury/Mortality of a Listed Species	Magnitude or Intensity	According to the U.S. Endangered Species Act, this impact threshold applies at the individual level so therefore applies to any mortality of a listed species and any impact that has more than a negligible potential to result in unpermitted take of an individual of a listed species. Excludes permitted take.	Does not apply in the case of mortality (any mortality unless related to authorized take falls under *likely to adversely affect* category); applies to a negligible injury that does not meet the threshold of take due to its low level of effect and/or ability to fully mitigate the effect; includes permitted take	No measurable effects on listed species
	Geographic Extent	Any geographic extent of mortality or any extent of injury that could result in take of a listed species	Any geographic extent that does not meet the threshold of take due to its low level of effect and/or ability to fully mitigate the effect; typically applies to one or very few locations	No measurable effects on listed species
	Duration or Frequency	Any duration or frequency that could result in take of a listed species	Any duration or frequency that does not meet the threshold of take due to its low level of effect and/or ability to fully mitigate the effect; typically applies to infrequent, temporary, and short-term effects	No measurable effects on listed species
Indirect Effects from Disturbance or Displacement Resulting in Reproductive Effects	Magnitude or Intensity	Any reduction in breeding success or survivorship of offspring of a listed species	Changes in breeding behavior (e.g., minor change in breeding timing or location) that are not expected to result in reduced reproductive success or survivorship of offspring	No measurable effects on listed species
	Geographic Extent	Reduced breeding success or survivorship of offspring of a listed species at any geographic extent	Changes in breeding behavior at any geographic extent that are not expected to result in reduced reproductive success or survivorship of offspring of listed species; typically applies to one or very few locations	No measurable effects on listed species
	Duration or Frequency	Any duration or frequency that could result in reduced breeding success or survivorship of offspring of a listed species	Infrequent, temporary, or short-term changes in breeding behavior that do not reduce breeding success or survivorship of offspring of a listed species within a breeding season	No measurable effects on listed species

Type of Effect	Effect Characteristic	Impact Level at the Programmatic Level		
		May Affect, Likely to Adversely Affect	**May Affect, Not Likely to Adversely Affect**	**No Effect**
Indirect Effects From Disturbance or Displacement Resulting in Behavioral Changes	Magnitude or Intensity	Disruption of normal behavior patterns (e.g., breeding, feeding, or sheltering) that could result in take of a listed species	Minor behavioral changes that would not result in take of a listed species	No measurable effects on listed species
	Geographic Extent	Any geographic extent that could result in take of a listed species	Changes in behavior at any geographic scale that are not expected to result in take of a listed species; typically applies to one or very few locations	No measurable effects on listed species
	Duration or Frequency	Any duration or frequency that could result in take of a listed species	Infrequent, temporary, or short-term changes that are not expected to result in take of a listed species	No measurable effects on listed species
Direct or indirect effects on habitats (including designated critical habitats) that affect population size and long-term viability for listed species	Magnitude or Intensity	Effects to any of the essential features of listed species habitat that would diminish the value of the habitat for the survival and recovery of the listed species	Effects to listed species habitat that would not diminish the functions or values of the habitat for the species for which the habitat was designated	No measurable effects on listed species habitat
	Geographic Extent	Effects to listed species habitat at any geographic extent that would diminish the value of the habitat for listed species. Note that the *likely to adversely affect* threshold for geographic extent depends on the nature of the effect. Some effects could occur at a large scale but still not appreciably diminish the habitat function or value for a listed species. Other effects could occur at a very small geographic scale but have a large adverse effect on habitat value for a listed species.	Effects realized at any geographic extent that would not diminish the functions and values of the habitat for the listed species; typically applies to one or few locations within a habitat known to be used by listed species	No measurable effects on listed species habitat
	Duration or Frequency	Any duration or frequency that could result in reduction in habitat function or value for a listed species	Any duration or frequency that would not diminish the functions and values of the habitat for which the habitat was designated; typically applies to Infrequent, temporary, or short-term changes	No measurable effects on listed species habitat

As discussed in Section 8.1.6.6, Threatened and Endangered Species and Species of Conservation Concern, numerous listed species occur in Puerto Rico. Listed species are protected under federal and territory regulations and, in most cases, a permit or other authorization is required for take[2] of a listed species. There are 95 federally and territory-listed species in Puerto Rico. Of the 95 federally and territory-listed species, 50 are plants, 8 are birds, 6 are marine mammals, 4 are marine reptiles (sea turtles), 7 are terrestrial reptiles, 6 are amphibians, 4 are fish, and 10 are marine invertebrates (*USFWS 2015*; *NMFS 2015*; *PRDNER 2005*). There are no federal candidate species or species of concern. Federally listed species are under the jurisdiction of the United States (U.S.) Fish and Wildlife Service (USFWS) or the National Marine Fisheries Service (NMFS) and territory-listed species are under the jurisdiction of the Puerto Rico Department of Natural and Environmental Resources. Twelve species in Puerto Rico have critical habitat that has been designated by the USFWS or NMFS (*USFWS 2012*; *NMFS 2015*). Table 8.2.6.6-2 provides key information about the federal and territory-listed species and designated critical habitats, summarized by taxonomic group.[3]

As summarized in Table 8.2.6.6-2, most of the federally listed species fall under the endangered[4] category (62 of 85) and most of these species are plants. Most of the territory-listed species fall under the critically endangered category (42 of 76) and most of these species are also plants.

Table 8.2.6.6-2: Summary of Information on Federally and Territory-Listed Species in Puerto Rico

Taxonomic Group (Total Number of Species)	Listing Status and Number of Species in Each Listing Category[a]						
	Federally Endangered	Federally Threatened	Federal Critical Habitat	Territory Critically Endangered	Territory Endangered	Territory Threatened	Key Habitat
Plants (50)	44	6	1[b]	30	15	0	Variety of forested, meadow, coastal, and wetland habitats
Marine Mammals (6)	6	0	0	0	4	0	Five species are whales that occur in marine waters and one species is a manatee that occurs in coastal habitats, particularly seagrass

[2] *Take* is defined differently by various federal and territorial regulations but the most commonly accepted definition is that of the U.S. Endangered Species Act (ESA). This act defines take as “to harass, harm, pursue, hunt, shoot, wound, trap, capture, collect, or attempt to engage in any such conduct.” The act further defines *harm* as “significant habitat modification or degradation that results in death or injury to listed species by significantly impairing behavioral patterns such as breeding, feeding, or sheltering,” and *harass* as “actions that create the likelihood of injury to listed species to such an extent as to significantly disrupt normal behavior patterns which include, but are not limited to, breeding, feeding or sheltering.”

[3] A taxonomic group is a group of biological organisms that have shared characteristics.

[4] According to the ESA, an *endangered species* means any species in danger of extinction throughout all or a significant portion of its range.

Taxonomic Group (Total Number of Species)	Listing Status and Number of Species in Each Listing Category[a]						
	Federally Endangered	**Federally Threatened**	**Federal Critical Habitat**	**Territory Critically Endangered**	**Territory Endangered**	**Territory Threatened**	**Key Habitat**
Reptiles (11)	6	3	5[d]	3	6	0	Four species are sea turtles that occur in marine and coastal habitats and seven are terrestrial reptiles that occur in forests and rocky habitats
Amphibians (6)	1	3	3 [e]	3	1	1	Caves, forests, and rocky habitats
Birds (8)	5	3	1[c]	1	5	0	Forest and beach/marine habitats
Fish (4)	0	2	0	2	1	0	Marine waters
Invertebrates (10)	0	7	2[f]	3	0	0	Two species are cave shrimp, one species is a butterfly that uses open grassland habitats, and seven are corals that occupy reefs in marine waters
TOTAL (95)	**62**	**24**	**12**	**42**	**32**	**1**	

Sources: NOAA 2016; USFWS 2016a; USFWS 2015; USFWS 2012; NMFS 2015; PRDNER 2005

[a] In Puerto Rico, 78 species are both federally and territory-listed so the number of species summarized for the listing categories is greater (173) than the total number of listed species (95).
[b] Federally designated critical habitat has been established for one plant (*Varronia rupicola*) in the following locations in Puerto Rico: Montalva, Guánica Commonwealth Forest, Montes de Barinas, Peñon de Ponce, Punta Negra, Puerto Ferro, Cerro Playuela, and Vieques Island.
[c] Federally designated critical habitat has been established for one bird species, the yellow-shouldered blackbird (*Agelaius xanthomus*), encompassing all of Mona Island and portions of the main island of Puerto Rico.
[d] Federally designated critical habitat has been established for five reptile species in the following locations:

- Green sea turtle (*Chelonius mydas*)–Culebra Island coastal waters, including outlying keys.
- Hawksbill turtle (*Eretmochelys imbricata*)–Mona and Monito islands coastal waters, northern Culebra Island, southern Cayo Norte, and southwest, east, and north beaches of Culebrita Island.
- Mona boa (*Epicrates monensis monensis*)–All of Mona Island.
- Mona ground iguana (*Cyclura cornuta stejñegeri*)–All of Mona Island.
- Monita gecko (*Sphaterodactylus mocropitecus*)–All of Isla Monito.

[e] Federally designated critical habitat has been established for three amphibian species in the following locations:

- Guajon (*Eleutherodactylus cooki*)–Portions of Humacao, Juncos, Las Piedras, Maunabo, Patillas, San Lorenzo, and Yabucoa.
- Golden coqui (*Eleutherodactylus jasper*)–Cerro Avispa, Monte el Gato, and Sierra de Cayey at elevations above 2,100 feet mean sea level.
- Ilanero coqui (*Eleutherodactylus juanariveroi*)–Portions of Toa Baja.

[f] Federally designated critical habitat has been established for elkhorn and staghorn corals (*Acropora* spp.) on coastal reefs surrounding Puerto Rico.

Listed species would be subject to the same potential impacts described for vegetation, wildlife, and fish (Section 8.2.6.3, Terrestrial Vegetation, Section 8.2.6.4, Wildlife, and Section 8.2.6.5, Fisheries and Aquatic Habitats). However, the magnitude of such impacts on listed species have the potential to be greater because of the reduced population size and/or limited geographic distribution of listed species and the importance of designated critical habitats and other habitats known to support listed species for the maintenance of those populations.

Given the nature of this programmatic evaluation, and because the Proposed Action could potentially cover a wide variety of actions that would take place in various landscapes, the potential impacts to listed species discussed in this section are presented as a range of possible impacts to the major taxonomic groups that encompass the listed species in Puerto Rico (i.e., plants, marine mammals, birds, reptiles, amphibians, fish, and invertebrates).

Description of Environmental Concerns

The following types of direct and indirect effects were considered in evaluating the potential impact of the Proposed Action on listed species (see Table 8.2.6.6-1 for further details):

- Direct injury or mortality—includes the taking (removal or loss) of a listed species (individual or population) due to physical injuries, extreme stress, or death of an individual from interactions associated with the Proposed Action;
- Indirect effects from disturbance or displacement—includes changes in an individual or population's habitat use or life history pattern due to disturbance from increased noise and vibration, human activity, visual disturbance, and associated transportation activity; increased competition for resources or habitat due to displacement of individuals from the affected area into the territory of other animals; or other indirect effects that ultimately cause mortality, decreased fitness, or reduced breeding in the future population; and
- Direct or indirect effects on habitats for listed species that affect population size and long-term viability for listed species—direct habitat effects are primarily physical disturbances that result in alterations in the amount or quality of a habitat. Indirect habitat loss can occur through preventing an animal from accessing an optimal habitat (e.g., breeding, forage, or refuge), either by physically preventing use of a habitat or by causing an animal to avoid a habitat, either temporarily or long-term.

Any of the listed species with individuals, populations, or habitat in the vicinity of activities related to the Proposed Action could be subject to one or more of the above potential impacts from the Proposed Action; however, implementation of BMPs and mitigation measures, as developed in consultation with the appropriate resource agency, could avoid potential impacts on some species and reduce potential impacts on others. The nature and extent of potential impacts to listed species would vary depending on many factors, including but not limited to, the species, the location and extent of the Proposed Action activity, the time of year, and the duration of deployment.

The following sections define and describe each of these potential impacts according to the taxonomic groups encompassing the listed species in Puerto Rico.

Plants

Fifty federally and territory-listed plant species occur in Puerto Rico (*USFWS 2015*; *NMFS 2015*; *PRDNER 2005*). One of the federally listed plant species, *Varronia rupicola,* has federally designated critical habitat in Puerto Rico (*USFWS 2012*). This critical habitat occurs in four units in mainland Puerto Rico and three on Vieques Island (*USFWS 2012*). The 50 species occur in a variety of habitats that encompass multiple forest types, open habitats, and coastal and beach habitats. Potential impacts of Proposed Action activities on listed plants include direct mortality or injury, habitat loss, and habitat disturbance/degradation. Consultation with USFWS and/or the Puerto Rico Department of Natural and Environmental Resources may be conducted to avoid or minimize potential impacts to listed plant species or their habitats.

Marine Mammals

Five federally listed whale species occur in the offshore marine waters surrounding Puerto Rico (*NMFS 2015*). FirstNet is unlikely to impact whales because deployment activities would only take place in nearshore or inland waters. Such activities would be conducted using small- to medium-sized vessels that are highly maneuverable and could, therefore, easily avoid interaction with any whales that could incidentally occur in nearshore waters.

A potential impact to listed whale species is disturbance from underwater noise. Noise associated with the installation of cables in the near/offshore waters of Puerto Rico could potentially impact whale behavior or migration patterns; however, the marine activities related to the Proposed Action are very limited in nature and would occur in nearshore environments where whales are not expected to occur, so risks to whales from marine noise are expected to be low. Greater human activity of longer duration would increase the likelihood that listed whale species would avoid affected areas, possibly being excluded from essential resources. The degree to which habitat exclusion could affect any of the listed whale species depends on many factors, including the context and duration of the noise exposure and the individual's experience, life stage, and conditioning. However, as stated above, the potential impacts associated with the Proposed Action are unlikely to impact whales; the likelihood of any impacts could be further reduced with implementation of appropriate BMPs and mitigation measures if deemed necessary and developed through consultation with the appropriate resource agency. Potential impacts from the Proposed Action would likely be short-term, not wide ranging, and below sound exposure impact thresholds[5] and thus would not adversely affect listed whale species.

One other listed species of marine mammal occurs in Puerto Rico, the West Indian manatee (*Trichechus manatus*). This species is listed as federally endangered and it inhabits calm and shallow coastal and inland waters, primarily those with seagrass beds in marine environments, and other aquatic vegetation (e.g., water hyacinth and hydrilla species) in estuarine and freshwater environments (*USFWS 2015*). Manatees are slow moving and often hover just below

[5] Sound exposure impact thresholds developed by *Southall et al.* (*2007*) define specific sound levels above which measurable transient effects (Level B) or permanent effects (Level A) could occur on the hearing of marine mammal species. Level A and B thresholds have been established for seals (all species considered as one group) and for whales, dolphins, and porpoises (all species considered as one group) (*Southall et al. 2007*).

the water surface so they are subject to vessel strike (*USFWS 2015*). Manatee sensitivity to underwater noise is unknown but thought to be similar to other marine mammals (*Marsh et al. 2002*). As such, the potential impacts of the Proposed Action activities on manatees would be very minor and similar to that described above for whales. Implementation of BMPs and mitigation measures, as developed through consultation with the appropriate resource agency, could substantially reduce the potential impacts of the Proposed Action to this species.

Reptiles

Of the four species of sea turtles that occur in Puerto Rico, two have major nesting sites on Puerto Rico beaches (*Sea Turtle Conservancy 2015a*; *USFWS 2015*) and federal critical habitat has been designated for two of the species. Sea turtles typically return to the same sites to nest each year so the nesting areas are well known by local sea turtle experts, including staff at the Puerto Rico Department of Natural and Environmental Resources, and consultation with these experts would facilitate avoidance of Proposed Action activities within or near sea turtle nesting beaches and designated critical habitats. As such, potential impacts to listed turtle species as a result of the Proposed Action would likely be primarily related to vessel strike during marine vessel-based deployment or maintenance activities, which are expected to be minimal as described above for marine mammals due to the very limited nature and location of the marine activities associated with the Proposed Action. As described above for marine mammals, BMPs and mitigation measures, as developed through consultation with the appropriate resource agency, could reduce the potential for impacts to sea turtles to negligible, if at all. Marine-based activities related to the Proposed Action could displace individual turtles from the area around the work zones; however, this displacement would be temporary and would not notably alter migratory routes or foraging behavior of individuals over the long term. Avoiding Project activities within or near seagrass habitats, which marine turtles use for foraging, would notably reduce the potential impacts to foraging turtles.

Any lighting erected or used along the coast for Proposed Action Activities could disrupt movement patterns and breeding behavior of sea turtles in the vicinity of the lit area. Artificial lighting can discourage females from nesting and disorient hatchlings, attracting them towards land rather than the ocean, which makes them vulnerable to predation[6] and other sources of mortality (*Sea Turtle Conservancy 2015b*). Minimization of coastal lighting, particularly within 500 feet of a known nesting beach, and use of turtle safe lighting instead of normal lights (low-pressure sodium-vapor lighting or red lights that emit a very narrow portion of the visible light spectrum) would minimize the potential impacts to nesting green turtles and hatchlings (*Sea Turtle Conservancy 2015*).

The other seven species of listed reptiles in Puerto Rico include three snakes, one gecko, two anoles, and one iguana (*USFWS 2015*; *PRDNER 2015*). These species occupy a variety of forested, grassland, rocky, and cave habitats. Critical habitat has been designated for three of the federally listed species: the Mona boa (*Epicrates monensis monensis*), Mona ground iguana

[6] Predation is therelationship between two organisms of different species in which one of them acts as predator that captures and feeds on the other organism that serves as the prey.

(*Cyclura cornuta stejñegeri*), and the Monita gecko (*Sphaterodactylus mocropitecus*) (*USFWS 2012*). The critical habitat for the Mona boa and the Mona ground iguana encompasses all of Mona Island and the critical habitat for the Monita gecko encompasses all of Monito Island (*USFWS 2012*).

Potential impacts of Proposed Action activities on the seven listed terrestrial reptile species include direct mortality or injury, habitat loss, and habitat disturbance/degradation. Consultation with USFWS and/or the Puerto Rico Department of Natural and Environmental Resources may be conducted to identify suitable avoidance, minimization, and mitigation measures to avoid or minimize potential impacts to listed reptile species or their habitats.

Amphibians

The six species of federally and territory-listed amphibians in Puerto Rico occur in forest, rocky habitats, and caves and are known only from specific locations in Puerto Rico (*USFWS 2015*; *IUCN 2015*). Federally designated critical habitat has been established for three of the listed amphibians.

Potential impacts of Proposed Action activities on these species include direct mortality or injury, habitat loss, and habitat disturbance/degradation. The extremely limited distribution of these species may make avoidance of known habitats and species locations feasible. Consultation with USFWS and/or the Puerto Rico Department of Natural and Environmental Resources may be conducted to avoid or minimize potential impacts to listed amphibian species or their habitats.

Birds

All seven species of federally and territory-listed species of birds in Puerto Rico are endemic[7] to Puerto Rico and are limited to forest habitats, especially preferring montane forests (*USFWS 2015*; *PRDNER 2015*; *IUCN 2015*). The other species, the roseate tern (*Sterna dougallii dougallii*), is a waterbird that occurs in marine habitats and nests on beaches throughout the Caribbean. Federally designated critical habitat has been established for one of the listed bird species, the yellow-shouldered blackbird (*Agelaius xanthomus*), encompassing all of Mona Island and portions of the main island of Puerto Rico. Critical habitat has been proposed for a second species, the elfin-wood warbler (*Setophaga angelae*), by the USFWS in June 2016 (*USFWS 2016b*).

The most notable potential direct impacts to listed bird species from the Proposed Action would be injury or death of individuals from equipment deployment (e.g., birds could strike or get entangled within equipment such as antennas, cables, towers, and above-ground communication lines). Such potential impacts to adult birds would be unlikely given that adults are highly mobile and would disperse from Proposed Action activities. Young birds or eggs would be most susceptible to direct or indirect mortality due to their immobility or limited mobility, but

[7] Endemic species are only found in one area or region.

implementation of BMPs and mitigation measures, as defined through consultation with the appropriate resource agency, could substantially reduce the likelihood of such potential impacts.

The more likely direct and indirect effects of the Proposed Action on listed birds would include habitat loss and disturbance and stress caused by noise, human activity (e.g., equipment deployment and human presence), and habitat degradation. The most significant of these potential impacts on listed bird species would be loss or degradation of important habitats, including breeding, migratory stopover, and overwintering sites, resulting in displacement and possibly reduced reproductive success or survival. The species of listed birds in Puerto Rico each have specific habitat preferences and are all susceptible (to varying degrees) to human disturbance and habitat alteration, particularly during the summer breeding season, migratory stopover, and overwintering periods. Disturbance from human activity, noise, vibration, and habitat degradation could cause abandonment of nesting sites, stopover, or overwintering areas resulting in adverse reproductive effects in breeding birds or reduced survivorship of migrating or overwintering birds. If the disturbance occurs late in the breeding season, individuals may not reattempt to nest following disturbance, resulting in the loss of a full breeding year for the affected species in a given area. If the disturbance occurs early in the breeding season, individuals could reattempt to nest if suitable habitat exists and it is not already occupied by other individuals. If the new habitat is suboptimal, reduced adult and immature bird survivorship, reduced reproductive rates, or reduced offspring survivorship could occur. Single disturbance events would have lower potential impacts on listed birds than repeated disturbances that are unpredictable in terms of the timing, type, or magnitude of the disturbance. Greater human activity of longer duration would increase the likelihood that birds would avoid the affected area, possibly resulting in permanent displacement or exclusion from essential resources.

Potential disturbance-related impacts could be avoided or minimized by siting Proposed Action activities away from listed species habitats, timing them outside of critical breeding, migratory stopover, or overwintering periods, or if such avoidance measures are not feasible, limiting the duration of activities within or near potential and known listed species habitats. Consultation with the USFWS and Puerto Rico Department of Natural and Environmental Resources would identify other specific measures to reduce the potential impacts of the Proposed Action activities on listed birds.

Mortality or injury from collisions or electrocutions with manmade cables and wires are of concern for avian species. Birds that are at greatest risk of collision events include those that are not highly maneuverable (large wingspan birds, heavy birds, and birds that fly in flocks) (*APLIC 2012*). Certain bird species and species groups are more susceptible to electrocution than others based on their size and behavior, which increases their risk of exposure to energized and/or grounded hardware (large birds versus small birds).

Three of the seven listed bird species in Puerto Rico are large-bodied and not highly maneuverable and one species is congregatory,[8] so they would be susceptible to collision and electrocution from new power lines and related structures that could be associated with the Proposed Action. BMPs and mitigation measures, as defined through consultation with the appropriate resource agency, could significantly reduce the likelihood of collision or electrocution by these or other bird species.

Fish

The federally listed shark species known to occur in Puerto Rico waters, the scalloped hammerhead shark (*Sphyrna lewini*), uses coastal and open ocean marine habitats, often exhibiting high site fidelity[9] to core use areas and regularly congregating in large groups during migration. The primary risks to this species associated with the Proposed Action would be direct mortality or injury from interaction with vessels or equipment operating in marine waters, general disturbance of benthic[10] habitat associated with dropping of cables or other communications equipment, and displacement from core use areas and stress or injury caused by underwater noise or vibration related to in-water (marine) Proposed Action activities. However, the marine activities related to the Proposed Action are very limited in nature so risks to the shark from vessel strike and marine noise are expected to be low.

Pups would be more susceptible to direct mortality or injury than adults because they are comparatively slow moving and highly bottom-oriented where they feed on bottom reef fish and crustaceans (*Baum et al. 2007*).

Sharks have a narrow hearing range but are sensitive to very low frequency sounds such as those generated by boat engines (*Chapuis 2015*). This type of sound can cause injury to an affected individuals' inner ear or other organs, which could render them unable to navigate and/or hunt for food effectively (*Chapuis 2015*). Proposed Action activities in marine environments would create underwater noise, although the duration and magnitude of the noise is expected to be minimal because of the very limited nature of the marine activities. Targeted BMPs and mitigation measures, as defined through consultation with NMFS, to avoid activities within important known shark use areas and seasons and to reduce underwater noise, could reduce the potential for and magnitude of potential adverse impacts on the scalloped hammerhead shark.

The other three listed species of fish, including two species of grouper and one species of mullet, are associated with coral reef (grouper) and estuarine habitats (mullet) so they would be vulnerable to potential impacts if Proposed Action activities occurred within or potentially impacted these habitats. Grouper congregate to spawn, so Proposed Action activities that occur during the spawning period and are located in or near spawning sites could adversely affect spawning grouper, resulting in lower reproductive success and survivorship of eggs. The mullet

[8] Congregatory describes the behavior of gathering in groups.
[9] Site fidelity is the tendency of an animal to return to a previously occupied location.
[10] Benthic habitats are anything associated with or occurring on the bottom of a body of water.

is estuarine[11] and migratory, so mullet would be very sensitive to any activities that negatively affect coastal estuarine habitats, particularly mangroves, or disrupt the continuity of the lower portions of rivers, coastal bays, or lagoon systems that mullet use during migration between freshwater and marine habitats. Proposed action activities within marine and estuarine environments would be minimal and activities would avoid reef habitats altogether. Other targeted BMPs and mitigation measure, if deemed necessary through consultation with the appropriate resource agency, could reduce the potential for, and magnitude of, potential adverse impacts on these fish species.

Invertebrates

The ten species of listed invertebrates from Puerto Rico include 2 shrimp, 1 butterfly, and 7 corals. The two species of cave shrimp occur in subterranean caves and have a very limited distribution (*PRDNER 2005*). Due to these species' limited distribution and highly specific habitat requirements, full avoidance of potential impacts to these species is feasible through informed sighting of Proposed Action activities.

The butterfly species inhabits open grassland habitats that contain its host plant *Oplonia spinose* so potential impacts of Proposed Action activities on this species could occur if grassland habitat that supports this species or its host plant is removed or degraded. FirstNet and/or their partners may consult with the Puerto Rico Department of Natural and Environmental Resources on projects with the potential to impact territorial-listed species in order to identify suitable minimization and mitigation measures to ensure that the Proposed Action would not result in adverse effects to these species.

The other seven listed invertebrate species known from Puerto Rico are corals and they all have federally designated critical habitat on coastal reefs surrounding Puerto Rico (*USFWS 2015*; *NMFS 2015*). Corals are sensitive to changes in water quality, including increases in turbidity[12] which causes sedimentation and reduced light infiltration (*Erftemeijer et al. 2012*). Sedimentation can smother adult corals and impede settlement of coral larvae while reduced light infiltration can limit the photosynthetic activity of algal symbionts,[13] all of which can result in decreased recruitment[14] and survivorship of corals (*Erftemeijer et al. 2012*). Proposed Action activities that occur in marine environments, even though they would be minimal, could cause direct loss of corals if bottom disturbing activities occurred in reef habitats. Potential indirect impacts to corals also could occur from increased turbidity and sedimentation as a result of bottom disturbing activities (e.g., dropping cables) related to the Proposed Action. Siting of Proposed Action activities to avoid designated critical habitats and other reef environments and

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[11] Estuarine areas are coastal areas where salt water from the sea mixes with rivers and streams, and may also be called bays, harbors, inlets, or lagoons.

[12] Turbidity is a measure of the clarity of a liquid. When many fine particles are suspended in water, the turbidity is high.

[13] Symbionts are either of two organisms that live in symbiosis (mutually beneficial relationship) with one another. Algae species are symbionts with corals.

[14] Recruitment is the number of new individuals reaching reproductive age in a given population over a given time interval (typically measured over a year).

their immediate vicinity would avoid potential direct impacts to listed coral species and limit the potential for increased turbidity to reach coral reefs.

Potential Impacts of the Preferred Alternative

This section assesses potential impacts associated with implementation of the Preferred Alternative, including construction/deployment and operation activities.

Potential Deployment Impacts

As described in Section 2.1.2, Proposed Action Infrastructure, implementation of the Preferred Alternative could result in the deployment of various types of facilities or infrastructure. Depending on the physical nature and location of the facility/infrastructure and the specific deployment requirements, some activities could result in potential impacts to listed species and critical habitats and others would not. These potential impacts would vary considerably by species and would be significantly influenced by deployment scenario, potential impact area, species presence, and site-specific conditions. The species that would be affected would depend on the potential impact area, the species' phenology,[15] and the nature and extent of the habitats affected. As explained in this section, various types of Preferred Alternative infrastructure could result in a range of *no effect* to *may affect, but not likely to adversely affect* at the programmatic level depending on the deployment scenario or site-specific conditions. Site-specific analysis may be required depending on the site conditions, the type of deployment, or any other permits or permissions necessary to perform the work.

<u>Activities Likely to Have No Effect</u>

Of the types of facilities or infrastructure development scenarios described in Section 2.1.2, Proposed Action Infrastructure, the following are likely to have *no effect* to listed species at the programmatic level under the conditions described below:

- Wired Projects
  - Use of Existing Conduit – New Buried Fiber Optic Plant: Disturbance, including noise, associated with the installation of fiber optic cable in existing conduit would be limited to entry and exit points of the existing conduit in previously disturbed areas. Although threatened and endangered species and their habitat could be impacted, it is anticipated that effects to threatened and endangered species would be temporary, infrequent, and likely not conducted in locations designated as vital or critical for any period.
  - Use of Existing Buried or Aerial Fiber Optic Plant or Existing Submarine Cable: Lighting up dark fiber would have *no effect* to listed species at the programmatic level because there would be no ground disturbance and very limited human activity.

[15] Phenology is the seasonal changes in plant and animal life cycles, such emergence of insects or migrations of birds.

- Satellites and Other Technology
  - Satellite-Enabled Devices and Equipment: It is anticipated that the installation of permanent equipment on existing structures and the use of portable devices that use satellite technology would not impact threatened and endangered because those activities would not require ground disturbance.
  - Deployment of Satellites: FirstNet does not anticipate launching satellites as part of the deployment of the nationwide public safety broadband network (NPSBN); however, it could include equipment on satellites that are already being launched for other purposes. As adding equipment to an existing launch vehicle would not result in ground or human disturbance in listed species habitats, it is anticipated that this activity would have *no effect* on listed species.

The above activities are expected to have *no effect* to listed species at the programmatic level because they involve collocation or shared use of existing facilities or do not require new ground disturbance or substantial construction or human activity. Should the above defined conditions not be met and activities require land disturbance, substantial construction activity, or implementation of physical security measures such as lighting, potential impacts to listed species would be similar to those described for new build activities below, although they would likely be lesser in magnitude due to the smaller scale of the activities required for collocation compared to new build scenarios.

Activities with the Potential to Affect

The infrastructure development scenarios or deployment activities that could be part of the Preferred Alternative and *may affect, but not likely to adversely affect* listed species at the programmatic level include: 1) New Build Scenarios (Buried Fiber Optic Plant, Aerial Fiber Optic Plant, Submarine Fiber Optic Plant, or Installation of Optical Transmission or Centralized Transmission Equipment); 2) New Wireless Communication Towers, Collocation on Existing Aerial Fiber Optic Plant, or Collocation on Existing Wireless Tower, Structure, or Building; and 3) Deployable Technologies.

The actions related to these components that could cause potential impacts to listed species include 1) land/vegetation clearing; 2) excavation and trenching; 3) construction of access roads; 4) installation or restructuring of towers, poles, or underwater cables; 5) installation of security/safety lighting and fencing; and 6) deployment of aerial platforms. Potential impacts to listed species associated with deployment of this infrastructure and related actions are further described below and in the previous taxa-specific descriptions (see Description of Environmental Concerns section above).

- Wired Projects
  - New Build–Buried Fiber Optic Plant: Plowing, trenching, or directional boring and the construction of points of presence (POPs),[16] huts, or other associated facilities or hand-holes to access fiber could result in potential impacts to listed species. Land/vegetation clearing and excavation activities associated with construction of POPs, huts, or other associated facilities could result in temporary or permanent habitat loss and direct injury/mortalities of species that are not mobile enough to avoid construction activities (e.g., slow moving species and young) or that are defending breeding sites or young (e.g., denning or pupping mammals or nesting birds). Disturbance and habitat degradation from noise and human activity associated with the above activities could result in displacement of individuals, changes in use of important migration pathways or breeding/rearing sites, indirect injury/mortality, and reproductive effects if BMPs and mitigation measures, as defined through consultation with the appropriate resource agency, are not implemented. In-water activities, although such activities would be minimal and limited to nearshore and inland waters, could cause vessel strike and/or auditory and potential disturbance impacts on listed fish, sea turtles, and/or marine mammals.
  - New Build–Aerial Fiber Optic Plant: The installation of new poles and hanging cable and associated security, safety, or public lighting components as well as the construction of access roads, POPs, huts, or facilities to house outside plant equipment could result in potential impacts to listed species. Potential impacts would vary depending on the number and location of individual poles or other facilities installed, but would primarily occur to terrestrial species as a result of habitat loss or degradation and/or disturbance from construction noise and human activity. Loss of fish habitat or stress on listed fish species could occur if new equipment were installed near or in streams, rivers, coastlines, or wetlands. Sea turtles could potentially be adversely impacted by any lighting that is used or installed at or in the vicinity of turtle nesting beaches.
  - Collocation on Existing Aerial Fiber Optic Plant: Land clearing and excavation during replacement of poles and structural hardening could result in direct injury/mortality, reproductive effects, behavioral changes, and loss/degradation of designated critical habitat to threatened and endangered species. Noise disturbance from heavy equipment use associated with these activities as well as with installing new fiber on existing poles could result in reproductive effects or behavior changes.
  - New Build–Submarine Fiber Optic Plant: The installation of cables in limited nearshore marine or inland freshwater environments and construction of landings and/or facilities on the shore to accept submarine cables could potentially impact listed species, particularly fish, marine mammals, and sea turtles. Effects could include direct or indirect injury/mortality; habitat loss or alteration; and disturbance/displacement from

[16] POPs are connections or access points between two different networks, or different components of one network.

underwater noise and vibration. If activities occurred during critical time periods, effects to migratory patterns or reproduction could occur. However, the marine activities related to the Preferred Alternative are very limited in nature so risks to listed freshwater and marine species are expected to be low.

- Installation of Optical Transmission or Centralized Transmission Equipment: If installation of transmission equipment occurs in existing boxes or huts, there would be *no effect* to listed species at the programmatic level because there would be no ground disturbance and very limited human activity. However, if installation of transmission equipment required construction of access roads, trenching, and/or land clearing, such disturbance could result in direct injury/mortality of threatened and endangered species as described for other New Build activities. Reproductive effects, behavioral changes, and loss/degradation of designated critical habitat could also occur as a result of construction and resulting disturbance.

- Wireless Projects
  - New Wireless Communication Towers: Installation of new wireless towers and associated structures (generators, equipment sheds, fencing, security and aviation lighting, electrical feeds, and concrete foundations and pads) or access roads could result in potential impacts to terrestrial listed species. Land/vegetation clearing, excavation activities landscape grading, and other disturbance activities during the installation of new wireless towers and associated structures or access roads could result in direct injury/mortality, habitat loss, alteration or fragmentation, and effects to migratory or habitat use patterns. Security lighting could diminish habitat quality for listed species, particularly birds and sea turtles.
  - Collocation on Existing Wireless Tower, Structure, or Building: Collocation would involve mounting or installing equipment (such as antennas or microwave dishes) on an existing tower or structure which would not result in impacts to threatened and endangered species. However, if replacement towers or structural hardening are required, impacts would be similar to new wireless construction. Hazards related security/safety lighting and fencing may produce direct injury/mortality, reproductive effects, and behavioral changes. For a discussion of radio frequency emissions and potential impacts, refer to Section 2.4, Radio Frequency Emissions.
- Deployable Technologies
  - Implementation of deployable technologies including Cell on Wheels, Cell on Light Truck, or System on Wheels could result in direct injury/mortalities to terrestrial listed species on roadways. Construction of staging areas could cause potential aquatic habitat impacts if they were constructed near or in lakes, streams, rivers, coastlines, or wetlands. Implementation of Deployable Airborne Communications Architecture is not anticipated to impact threatened and endangered species or their habitat.

Potential Impacts to Listed Species

FirstNet is committed to avoidance of impacts to listed species and their known habitats to the maximum extent practicable. The key time to implement avoidance actions is during siting and deployment, prior to and during Preferred Alternative activities. Site-specific analysis may be required depending on the site conditions, the type of deployment, or any other permits or permissions necessary to perform the work.

For activities that could potentially affect listed species, FirstNet and/or their partners would enter into informal or formal consultation, as appropriate, with USFWS and/or NMFS, as well as Puerto Rico Department of Natural and Environmental Resources for territory-listed species, to identify measures to be implemented to ensure potential impacts to listed species would not rise to the level of take or, should take be unavoidable, that it would be fully authorized through receipt of an Incidental Take Permit from USFWS or NMFS for federally listed species or authorization from Puerto Rico Department of Natural and Environmental Resources for territory species. FirstNet is committed to perform all required monitoring or mitigation activities associated with any federally- or territorially-listed species.

In summary, with effective implementation of BMPs and mitigation measures, as needed and defined through consultation with the appropriate resource agency, the Preferred Alternative *may affect, but is not likely to adversely affect* listed species at the programmatic level. Site-specific analysis may be required depending on the site conditions, the type of deployment, or any other permits or permissions necessary to perform the work to determine the potential impacts on listed species at specific proposed activity locations, once those locations are determined. See Chapter 11, BMPs and Mitigation Measures, for a listing of BMPs and mitigation measures that FirstNet and/or their partners would require, as practicable or feasible, to help avoid or minimize the potential impacts to these resources.

Potential Operation Impacts

As described in Section 2.1.2, Proposed Action Infrastructure, operation activities associated with the Preferred Alternative would consist of routine maintenance and inspection of the facilities. Any major infrastructure replacement conducted as part of ongoing system maintenance would result in potential impacts similar to the abovementioned deployment impacts. The species that would be affected and the nature and magnitude of potential impacts would depend on many factors, including but not limited to the impact location related to listed species use areas, the species' phenology, and the nature and extent of the habitats affected.

It is anticipated that potential impacts to listed species *may affect, but not likely to adversely affect* with BMPs and mitigation measures at the programmatic level (as defined through consultation with the appropriate resource agency) to listed species associated with routine inspections of the Preferred Alternative, assuming that the same access routes used for deployment are also used for inspections. This is because routine inspections would be short-term in nature, would not involve any new potential habitat impacts, and would not result in significant disturbance or displacement. Site maintenance activities, including mowing and application of herbicides *may affect, but not likely to adversely affect* listed species at the programmatic level, as the activity would be infrequent and done in compliance with BMPS and mitigation measures (as defined through consultation with the appropriate resource agency).

During operations, direct injury/mortality of listed bird species could occur from collisions and/or entanglements with communication lines, towers, and aerial platforms. In addition, the presence of new access roads and communication line rights-of-way could increase human use of the surrounding areas, which could increase disturbance to or hunting or fishing of listed species or degradation of listed species habitats. If external generators were used, noise disturbance could potentially impact habitat use patterns or displacement of terrestrial listed species. For potential impacts to birds from radio frequency emissions, see Section 8.2.6.4, Wildlife.

Deployable Aerial Communications Architecture, including deployment of drones, balloons, blimps, and piloted aircraft could potentially impact listed bird species by direct or indirect injury/mortality and disturbance and/or displacement. The magnitude of these effects would depend on the location, timing, and frequency of deployments in relation to listed bird use areas. Other listed species would not be affected by deployable aerial communications equipment because, based on their habitat requirements, the likelihood of their interaction with aerial equipment is very low to nil. Aerial equipment could fall, resulting in injury or death of a listed species individual and/or habitat disturbance. If aerial equipment were to fly at low levels over marine mammal haulout sites or seabird nest locations, mass flight response could occur resulting in trampling death of individuals and/or abandonment of haulout or nest sites.

Such potential impacts *may affect, but not likely to adversely affect* listed species at the programmatic level provided that any necessary federal and/or territory authorizations regarding listed species are obtained. Mitigation measures, as defined through consultation with the appropriate resource agency, would be implemented. Implementation, as practicable or feasible, of the operational BMPs could further reduce the potential for impacts on listed species.

Table 8.2.6.6-3 summarizes the impact significance determinations for each taxonomic group as a result of deployment and operation of the Preferred Alternative. Potential impacts to listed species were considered significant (i.e., adverse effect) if listed species or their habitats could be adversely affected over relatively large areas; a large proportion of a listed species' population within a region could be adversely affected; or if disturbances related to the Preferred Alternative could cause significant reductions in population size or distribution of a listed species. The duration of a potential impact also affected its significance level: temporary impacts (e.g., noise associated with construction) were considered less significant than permanent impacts (e.g., land conversion). The impact ratings assume full and successful implementation of BMPs and mitigation measures, as defined through consultation with the appropriate resource agency. Additional BMPs and mitigation measures, as defined in Chapter 11, may be implemented as appropriate to help further minimize potential impacts.

Table 8.2.6.6-3: Determination of Impact Significance for Listed Species as a Result of the Preferred Alternative

Taxa	Impact Determination at the Programmatic Level	Rationale for Determination
Plants	*May affect, not likely to adversely affect*	The listed plant species occur in many habitats known from Puerto Rico. Mitigation measures, as defined through permitting and/or consultation with the USFWS and/or Puerto Rico Department of Natural and Environmental Resources, would be implemented as part of deployment and operation of the Preferred Alternative to help avoid or reduce potential impacts to listed plant species. Implementation of BMPs, as practicable or feasible, could further reduce the potential for impacts.
Marine mammals	*May affect, not likely to adversely affect*	The marine-based activities of the Preferred Alternative are not extensive and they are limited to nearshore and inland waters. They would be of short duration and spatial extent and would avoid key listed species habitats and activity periods.
Birds[a]	*May affect, not likely to adversely affect*	The listed bird species occupy a variety of habitats in Puerto Rico, but most occur in forest and coastal/beach/marine habitats. The greatest potential impacts to listed birds include disturbance of birds during the breeding season, which generally occurs between April and July, and collision with project infrastructure. Each of the listed species has very specific nesting requirements so avoidance of breeding habitat is feasible, which makes it unlikely for potential significant adverse impacts from the Preferred Alternative on listed bird species.
Reptiles	*May affect, not likely to adversely affect*	Marine activities related to the Preferred Alternative are very limited in nature so risks to listed turtle species from vessel strike and marine noise are expected to be low.
Terrestrial Herptiles (Amphibians and Reptiles)	*May affect, not likely to adversely affect*	The listed herptile species occur in many habitats known in Puerto Rico. Implementation of BMPs and mitigation measures, as defined through consultation with the appropriate resource agency, could completely avoid or reduce potential impacts on listed herptile species.
Fish	*May affect, not likely to adversely affect*	Marine activities related to the Preferred Alternative are very limited in nature so risks to listed fish species from habitat alterations, vessel strike, and marine noise are expected to be low.
Invertebrates	*May affect, not likely to adversely affect*	The listed invertebrate species in Puerto Rico include cave shrimp, a butterfly, and corals. The cave shrimp have extremely limited distribution in subterranean caves so potential impacts to these species can be avoided. Marine activities would be minimal and would avoid coral reef habitats. FirstNet and/or their partners may consult with the Puerto Rico Department of Natural and Environmental Resources on projects with the potential to impact territorial-listed species to identify suitable minimization and mitigation measures to ensure that the Preferred Alternative would not result in adverse effects to these species. As such, potential adverse impacts from the Preferred Alternative on listed invertebrates are unlikely.

[a] For potential impacts to birds from radio frequency emissions, see Section 8.2.6.4, Wildlife.

Alternatives Impact Assessment

This section assesses potential impacts to listed species associated with the Deployable Technologies Alternative and the No Action Alternative.[17]

Deployable Technologies Alternative

Under the Deployable Technologies Alternative, a nationwide fleet of mobile communications systems would provide temporary coverage in areas not covered by the existing, usable infrastructure. There would be no collocation of equipment and no new construction associated with wired or wireless projects discussed above under the Preferred Alternative. Some limited construction could be associated with implementation such as land clearing or paving for parking or staging areas. The specific infrastructure associated with the Deployable Technologies Alternative (including land based and aerial technologies) would be the same as the deployable technologies implemented as part of the Preferred Alternative, but would likely be implemented in greater numbers, over a larger geographic extent, and used with greater frequency and duration. These increases could increase the magnitude of potential impacts to listed species compared with the Preferred Alternative, as further described below.

<u>Potential Deployment Impacts</u>

As explained above, implementation of deployable technologies could result in minor potential impacts from direct and indirect injury or mortality events, habitat loss, disturbance, or displacement. Greater frequency and duration of deployments could increase the magnitude of these potential impacts depending on the location of the deployments in relation to listed species use areas. However, even with the increased potential impact magnitude, impacts *may affect, but not likely to adversely affect* listed species or designated critical habitats at the programmatic level with implementation of BMPs and mitigation measures, as defined through consultation with the appropriate resource agency. Additional BMPs and mitigation measures, as defined in Chapter 11, may be implemented as appropriate to help further minimize potential impacts.

<u>Potential Operation Impacts</u>

As explained above, operation activities would consist of implementation and running the deployable technology and routine maintenance and inspections. As with the Preferred Alternative, potential impacts associated with routine operations, management, and monitoring would vary among species, season, and geographic region but *may affect, but not likely to adversely affect* any listed species or designated critical habitat at the programmatic level with implementation of BMPs and mitigation measures, as developed through consultation with the appropriate resource agency. Such consultation may facilitate avoidance of known listed species use areas to the maximum extent possible. If complete avoidance of listed species use areas would be impossible, consultation with USFWS, NMFS, and Puerto Rico Department of Natural and Environmental Resources, as applicable, would identify appropriate impact minimization

[17] As mentioned above and in Section 2.1.2, Proposed Action Infrastructure, the Preferred Alternative includes implementation of deployable technologies.

and mitigation actions. As such, the Deployable Technologies Alternative *may affect, but is not likely to adversely affect* listed species at the programmatic level.

The same BMPs and mitigation measures implemented for deployment and operation of the deployable technologies component of the Preferred Alternative would be applied to this alternative.

Table 8.2.6.6-4 summarizes the impact significance determinations for each taxonomic group under the Deployable Technologies Alternative. Deployment and operation of the Deployable Technologies Alternative *may affect, but not likely to adversely affect* any listed species at the programmatic level with implementation of BMPs and mitigation measures, as defined through consultation with the appropriate resource agency. Additional BMPs and mitigation measures, as defined in Chapter 11, may be implemented as appropriate to help further minimize potential impacts. *No effects* would occur to listed marine mammals, marine reptiles, fish, or invertebrates at the programmatic level as a result of this alternative because of the lack of activities within the aquatic habitats of these species.

Table 8.2.6.6-4: Determination of Impact Significance for Listed Species as a Result of the Deployable Technologies Alternative

Taxa	Impact Determination at the Programmatic Level	Rationale for Determination
Plants	*May affect, not likely to adversely affect*	Activities related to the Deployable Technologies Alternative would have very limited potential impacts on vegetation and habitats since minimal construction would occur. Mitigation measures, as defined through permitting and/or consultation with the USFWS and/or Puerto Rico Department of Natural and Environmental Resources, would be implemented as part of deployment and operation of the Deployable Technologies Alternative to help avoid or reduce potential impacts to listed plant species. Implementation of BMPs, as practicable or feasible, could further reduce the potential for impacts.
Marine mammals	*No effect*	Deployment and operation of Deployable Technologies Alternatives would not occur in marine waters or coastal habitats and thus would have *no effect* on listed marine mammal species.
Birds	*May affect, not likely to adversely affect*	Potential habitat impacts associated with this alternative are expected to be minimal due to the lack of new construction so potential direct impacts to listed bird species from this alternative are expected to be minimal. Potential disturbance-related impacts could occur or birds could collide with deployable equipment if located near bird use areas. Avoidance of known use areas and the bird breeding season to the extent possible could minimize the potential impacts to listed bird species.
Marine Reptiles	*No effect*	Deployment and operation of Deployable Technologies Alternatives would not occur in marine waters or coastal habitats and thus would have *no effect* on listed marine reptile species.
Terrestrial Herptiles (Amphibians and Reptiles)	*May affect, not likely to adversely affect*	Potential habitat impacts associated with this alternative are expected to be minimal due to the lack of new construction so potential direct impacts to listed herptiles species from this alternative are expected to be minimal.

Taxa	Impact Determination at the Programmatic Level	Rationale for Determination
Fish	*No effect*	Deployment and operation of Deployable Technologies Alternatives would not occur in marine waters or coastal habitats and thus would have *no effect* on listed marine mammal species.
Invertebrates	*No effect*	Activities related to this alternative would not occur in marine environments or caves so listed corals and cave shrimp would not be affected. Potential terrestrial habitat impacts would be minimal and would be located to avoid suitable or occupied habitats of the listed butterfly species and its host plant.

No Action Alternative

Under the No Action Alternative, the NPSBN would not be deployed; therefore there would be no associated construction or installation of wired, wireless, deployable infrastructure, satellites, and other technologies. As a result, there would be *no effects* to listed species because there would be no deployment or operation of the Proposed Action. Environmental conditions would therefore be the same as those described in Section 8.1.6.6, Threatened and Endangered Species and Species of Conservation Concern.

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8.2.7. Land Use, Airspace, and Recreation

8.2.7.1. Introduction

This section describes potential impacts to land use, airspace, and recreation in Puerto Rico associated with deployment and operation of the Proposed Action. Mitigation measures, as defined through permitting and/or consultation with the appropriate resource agency, would be implemented as part of deployment and operation of the Proposed Action to help avoid or reduce potential impacts to land use, airspace, and recreation. Implementation of best management practices (BMPs), as practicable or feasible, could further reduce the potential for impacts. Both mitigation measures and BMPs are discussed in Chapter 11, BMPs and Mitigation Measures.

8.2.7.2. Impact Assessment Methodology and Significance Criteria

The potential impacts of the Proposed Action on land use, airspace, and recreation were evaluated using the significance criteria presented in Table 8.2.7-1. As described in Section 8.2, Environmental Consequences, the categories of potential impacts are defined at the programmatic level as *potentially significant*, *less than significant with BMPs and mitigation measures incorporated*, *less than significant*, or *no impact*. Characteristics of each impact type, including magnitude or intensity, geographic extent, and duration or frequency, were used to determine the impact significance rating associated with each potential impact.

Given the nature of this programmatic evaluation, and because the Proposed Action could potentially cover a wide variety of actions that would take place in various landscapes, the potential impacts to land use, airspace, and recreation addressed in this section are presented as a range of possible impacts.

Table 8.2.7-1: Impact Significance Rating Criteria for Land Use, Airspace, and Recreation

Type of Effect	Effect Characteristic	Impact Level			
		Potentially Significant	**Less than Significant with BMPs and Mitigation Measures Incorporated**	**Less than Significant**	**No Impact**
Direct land use change (site of FirstNet facility installation or deployable base)	Magnitude or Intensity	Change in designated/permitted land use that conflicts with existing permitted uses, and/or would require a change in zoning	Effect that is *potentially significant*, but with BMPs and mitigation measures is *less than significant* at the programmatic level	Change in existing land use that is within permitted (by-right) uses	No change in land use
	Geographic Extent	Regional impacts observed throughout the state or territory		Effects realized at one location	No measurable effects
	Duration or Frequency	Permanent: land use altered indefinitely		Short-term: land use altered for as long as the entire deployment phase or a portion of the operations phase	No measurable effect
Indirect land use change (site of FirstNet facility installation or deployable base)	Magnitude or Intensity	New land use directly conflicts with surrounding land use pattern, and/or causes substantial restriction of land use options for surrounding land uses	Adverse effect that is *potentially significant*, but with BMPs and mitigation measures is *less than significant* at the programmatic level	New land use differs from, but is not inconsistent with surrounding land use pattern; minimal restriction of land use options for surrounding land uses	No measurable effects
	Geographic Extent	Regional impacts observed throughout the state or territory		Effects realized at one location	No measurable effects
	Duration or Frequency	Permanent: land use altered indefinitely		Short-term: land use altered for as long as the entire deployment phase or a portion of the operations phase	No measurable effect

Type of Effect	Effect Characteristic	Impact Level			
		Potentially Significant	**Less than Significant with BMPs and Mitigation Measures Incorporated**	**Less than Significant**	**No Impact**
Use of airspace (at and near site of FirstNet facility installation or deployable base)	Magnitude or Intensity	Complete change in flight patterns and/or use of airspace	Effect that is *potentially significant*, but with BMPs and mitigation measures is *less than significant* at the programmatic level	Alteration to air space usage is minimal	No measurable effects
	Geographic Extent	Regional impacts observed throughout the state or territory		Effects realized at one location	No measurable effects
	Duration or Frequency	Permanent: airspace altered indefinitely		Short-term: airspace altered for as long as the entire deployment phase or a portion of the operations phase	No measurable effect
Loss of access to public or private recreation land	Magnitude or Intensity	Total loss of access to recreation land	Effect that is *potentially significant*, but with BMPs and mitigation measures is *less than significant* at the programmatic level	Minor restricted access to recreation land	No measurable effects
	Geographic Extent	Most or all recreational land/sites in a state or territory		One (or a small number of) recreational site	No measurable effects
	Duration or Frequency	Persists during or beyond the life of the Proposed Action		Persists for as long as the entire deployment phase or a portion of the operations phase	No measurable effect
Loss of enjoyment of public or private recreation land (due to visual, noise, or other impacts that make recreational activity less desirable)	Magnitude or Intensity	Total loss of enjoyment, resulting in avoidance of activity at one or more sites	Effect that is *potentially significant*, but with BMPs and mitigation measures is *less than significant* at the programmatic level	Small reductions in visitation or duration of recreational activity	No measurable effects
	Geographic Extent	Most or all recreational land/sites in a state or territory		One (or a small number of) recreational site	No measurable effects
	Duration or Frequency	Persists during or beyond the life of the Proposed Action		Persists for as long as the entire deployment phase or a portion of the operations phase	No measurable effect

8.2.7.3. Description of Environmental Concerns

Direct and Indirect Land Use Change

Deployment and operation of new aboveground facilities associated with the Proposed Action, such as new towers, antennas, or other structures, could result in direct changes to land use where such deployment occurs on land not already used for telecommunications, industrial, or public utility activity.

As discussed in Section 8.2.9, Socioeconomics, the presence of permanent aboveground facilities could lead to reduced property values due to diminishment of aesthetic characteristics and the potential for perceived health impacts. Purchases of land for FirstNet buildout (as also discussed in Section 8.2.9) could also affect localized real estate market values. Such potential real estate impacts could indirectly impact the intensity or type of land use in residential or commercial neighborhoods near new FirstNet aboveground facilities.

Puerto Rico has relatively high residential vacancy rates and relatively low property values (see Section 8.1.9.4, Real Estate, Tax Revenues, Property Values, and Local Economic Activity). These factors imply the ability to relocate to avoid negative impacts associated with FirstNet; however, the territory's relatively low incomes could tend to make such relocations difficult.

The location of new telecommunications equipment, particularly larger aboveground facilities such as antennas or towers with aerial fiber optic plant, would likely be affected by local zoning regulations, as discussed in Section 8.1.7.2, Specific Regulatory Considerations. FirstNet and/or their partners will consider existing zoning and FirstNet and/or their partners may need to obtain zoning variances or other special permits to construct such facilities in some areas.

Use of Airspace

Deployment and operation of new aboveground facilities associated with the Proposed Action, particularly taller structures such as new towers and antennas, could add new obstructions to existing airspace. Use of Deployable Airborne Communications Architecture (DACA) could add the presence of new air traffic and/or aerial navigation hazards. Given the requirements of Federal Aviation Administration (FAA) Part 77 regulations (see Section 8.1.7.2, Specific Regulatory Considerations), such taller structures are unlikely to be built near airports.

Access to and Enjoyment of Recreation Land

Deployment of the Proposed Action could temporarily block or hinder access to recreation lands in Puerto Rico in cases where deployment activity occurs in the vicinity of the entrances to parks or other such lands. Access could also be affected in cases where construction vehicles must use or cross the access roads for recreation lands. Operation of the Proposed Action would not involve any routine or frequent closures of roads or trails; therefore, the Proposed Action is unlikely to prevent or hinder access to recreation lands.

As discussed above under Direct and Indirect Land Use Change and in Section 8.2.8, Visual Resources, the presence of new aboveground facilities or deployment activity could be perceived as an adverse visual impact. Such adverse perceptions are likely to occur in or near areas in Puerto Rico that are managed for recreational uses, visual resources, and/or preservation of natural environmental conditions (see Section 8.1.7.5, Recreation, and Figure 8.1.7-3). Puerto Rico residents and visitors often choose to live, stay near, and/or visit such lands because of their scenic beauty and environmental quality. Placement of new aboveground facilities within sight of such lands could create a perceived diminution of those aesthetic and environmental values in the eyes of Puerto Rico residents and visitors, thus potentially reducing the enjoyment they derive from living near or visiting recreation lands and facilities.

8.2.7.4. Potential Impacts of the Preferred Alternative

The following section assesses potential land use, airspace, and recreation impacts associated with implementation of the Preferred Alternative, including deployment and operation activities.

Potential Deployment Impacts

As described in Section 2.1.2, Proposed Action Infrastructure, implementation of the Preferred Alternative could result in the deployment of various types of facilities or infrastructure. As explained in this section, various types of Preferred Alternative infrastructure could result in a range of *no impacts* to *less than significant* impacts at the programmatic level, depending on the deployment scenario or site-specific conditions. Site-specific analysis may be required depending on the site conditions, the type of deployment, or any other permits or permissions necessary to perform the work.

Activities Likely to Have No Impacts

The following types of infrastructure development scenarios or deployment activities that could be part of the Preferred Alternative are likely to have *no impacts* at the programmatic level to land use, airspace, or recreation in Puerto Rico:

- Wired Projects
  - Use of Existing Conduit–New Buried Fiber Optic Plant: Installation of a new buried fiber optic plant within an existing conduit would have *no impact* on the use of airspace and would have no direct effects on land use or land ownership in Puerto Rico. Visible evidence of deployment is unlikely to affect land use or ownership decisions. In general, such effects would be temporary, with blockages of recreation access lasting only as long as deployment. If the deployment activities take place on non-paved roads, the visual evidence of deployment would diminish as affected areas revegetate.
  - Collocation on Existing Aerial Fiber Optic Plant: This activity would involve no new towers or other structures, and thus would not directly affect land use, land ownership, or use of airspace in Puerto Rico. While the addition of new aerial fiber optic plant to an existing aerial fiber optic transmission system would likely be visible, the change associated with this option is so small as to be essentially imperceptible, and thus would

not affect land uses or the enjoyment of recreation lands. While deployment (specifically, the stringing of new aerial fiber optic plant) could cause temporary blockage of recreation lands' access roads or trails, such activity would likely be so spread out and of such short duration as to be imperceptible to the vast majority of potential users.

- Use of Existing Buried or Aerial Fiber Optic Plant or Existing Submarine Cable: The use of existing fiber optic plant would involve no new aboveground facilities and no substantial new trenching. As a result, there would be no perceptible change in land use, land ownership, or use of airspace in Puerto Rico from this option. While deployment activity (particularly if a small amount of new buried fiber optic plant must be installed) could be visible, and could theoretically cause temporary blockage of recreation lands' access roads or trails, such activity would likely be so spread out and of such a short duration as to be imperceptible to the majority of potential users. If deployment activities take place on non-paved surfaces, the visual evidence of deployment would be temporary and diminish as affected areas revegetate.

- Satellites and Other Technologies
  - Satellite-Enabled Devices and Equipment: This activity would involve no new towers or other structures, and thus would not directly affect land use, land ownership, or use of airspace in Puerto Rico. While the addition of new satellite-enabled equipment to existing towers, structures, or buildings would likely be visible, the change associated with this option would be so small as to be essentially imperceptible, and thus would not affect land uses or the enjoyment of recreation lands. Deployment is unlikely to cause blockage of access routes for recreation lands due to the lack of substantial construction activity.
  - Deployment of Satellites: FirstNet does not anticipate launching satellites as part of the deployment of the nationwide public safety broadband network (NPSBN); however, it could include equipment on satellites that are already being launched for other purposes. As adding equipment to an existing launch vehicle would be very unlikely to impact land use, it is anticipated that this activity would have *no impact* to those resources.

Activities with the Potential to Have Impacts

The types of infrastructure development scenarios or deployment activities that could be part of the Preferred Alternative and result in potential impacts to land use, airspace, and recreation include the following:

- Wired Projects
  - New Build–Buried Fiber Optic Plant: Installation of a new buried fiber optic plant (i.e., new underground conduit) would have *no impact* on the use of airspace in Puerto Rico. Depending on the specific location, minor construction could be visible from existing residences, businesses, or recreation areas until revegetation was complete. Deployment could also temporarily block access to recreation areas. As discussed in

Section 8.2.7.3, Description of Environmental Concerns, visible evidence of deployment could indirectly affect land use or ownership decisions because the visible presence of infrastructure may be unappealing to home owners and buyers; however, once the area over the buried conduit has revegetated, there would likely be little visual evidence remaining. Similarly, the visible presence of infrastructure may diminish the enjoyment of recreation facilities and activities during deployment until revegetation has occurred—particularly in more rural recreation sites where the evidence of human activity is expected to be minimal. In general, such effects would be temporary, with blockages of recreation access lasting only as long as deployment; the visual evidence of deployment would diminish as affected areas revegetate. BMPs and mitigation measures (see Chapter 11, BMPs and Mitigation Measures) could further help to reduce the potential impact of this scenario.

- New Build–Aerial Fiber Optic Plant: The installation of a new aerial fiber optic plant (i.e., new wires on existing or new poles) could involve the permanent placement of new poles. New-Build-Aerial Fiber Optic Plan would have *no impact* on airspace as utility poles are in average 40 feet in height and do not intrude into useable airspace. Depending on the existing ownership and land use, this scenario could constitute a potential permanent impact on land use and ownership (if an easement is required for new pole placement). In addition, new poles could potentially constitute a discernable change in visual conditions (see Section 8.2.8, Visual Resources), and thus could indirectly affect land use, land ownership, and/or enjoyment of recreation (as described under the New Build–Buried Fiber Optic Plant option). As discussed for other scenarios, deployment of this scenario could result in temporary blockages of access routes to recreational lands. As it is likely that deployment of new wires on either new or existing poles would take place in established rights of way, and it is unlikely this activity would be noticeable beyond the short time it would take to install the new poles or place the new wire on existing poles. BMPs and mitigation measures (see Chapter 11) could help to avoid or minimize potential impacts.
- New Build–Submarine Fiber Optic Plant: Installation of a new submarine fiber optic plant in nearshore or inland waters would have *no impact* on the use of airspace. Depending on the existing ownership and use of affected land (including land required for and immediately adjacent to the submarine plant's onshore landing site), this scenario could constitute a small but potentially permanent impact on land use and ownership. While onshore landing sites would be visible (see Section 8.2.8, Visual Resources), it is unlikely that they would constitute a change in visual conditions sufficient to indirectly affect use or ownership of land not directly affected by this scenario. Depending on the specific location of these landing sites, the change in visual conditions caused by the presence of onshore landing sites could decrease the enjoyment of nearby recreational facilities—particularly if new submarine cables and onshore landing sites are installed near beaches or shorelines with scenic value. Offshore deployment of this scenario could limit access to nearshore recreation areas in the immediate vicinity of a new submarine fiber optic plant. Such effects would be more noticeable in nearshore areas or inland

bodies of water designated or managed for recreational activity, but could also be experienced in other coastal waters. BMPs and mitigation measures (see Chapter 11) could help to avoid or minimize the potential impacts.

- Installation of Optical Transmission or Centralized Transmission Equipment: Installation of new transmission equipment would have *no impact* on the use of airspace in Puerto Rico. Depending on their specific location, access roads associated with deployment of this scenario could temporarily affect land use or access to recreation in cases where access roads cross private property. The presence of deployment activity near recreational lands could temporarily diminish the enjoyment of recreation activities; however, as the deployment will be short-term (lasting several hours to several weeks), it is unlikely to cause any permanent impact. BMPs and mitigation measures (see Chapter 11) could further help to avoid or minimize potential impacts. While new transmission equipment in this scenario could be visible from private property and recreation areas in Puerto Rico, it is unlikely that their presence would noticeably affect land use or the enjoyment of recreational lands.

- Wireless Projects
  - New Wireless Communication Towers: Installation of new wireless communication towers would involve the permanent placement of new structures. Depending on the existing ownership and use of affected land (including land immediately adjacent to the towers), this scenario could constitute a potential permanent impact on land use and ownership. In addition, new structures could potentially constitute a discernable change in visual conditions (see Section 8.2.8, Visual Resources), and thus could indirectly affect land use, land ownership, and/or enjoyment of recreation. Depending on their specific height and proximity to one of Puerto Rico's airports, new structures could constitute a new obstruction to be managed by aviators. As discussed for other scenarios, deployment could result in temporary blockages of access routes to recreational lands. BMPs and mitigation measures (see Chapter 11) could help to avoid or minimize potential impacts.
  - Collocation on Existing Wireless Tower, Structure, or Building: There would be *no impacts* at the programmatic level to existing and surrounding land uses. The potential addition of power units, structural hardening, and physical security measures would not impact existing or surrounding land uses. Installation of antennas or microwaves to existing towers may cause temporary, localized restricted access to recreation lands or activities during installation, which may cause small reductions in visitation for the duration of installation.
- Deployable Technologies (all options)
  - The deployment of land-based deployable technologies (e.g., mobilizing vehicles) would have no direct effect on land use or ownership, and would have no permanent effects on the use of airspace or access to or enjoyment of recreation lands and activities in Puerto Rico. Implementation of DACA could result in temporary and intermittent potential

impacts to airspace. Deployment of tethered systems (such as balloons or blimps) could pose an obstruction hazard if deployed above 200 feet and near airports. Potential impacts to airspace (such as special use airspace and military training routes) may be possible depending on the planned use of drones, piloted aircraft, untethered balloons, and blimps (e.g., frequency of deployment, altitudes, proximity to airports and airspaces classes/types, length of deployment, etc.). Coordination with the FAA would be required to determine the actual impact and the required certifications. It is expected that FirstNet would attempt to avoid changes to airspace and the flight profiles (boundaries, flight altitudes, operating hours, etc.).

Potential Direct and Indirect Land Use and Land Ownership Impacts

Potential direct land use and land ownership impacts for the New Build–Aerial Fiber Optic Plant and Construction of New Wireless Communication Towers option would be *less than significant* at the programmatic level. These options would require permanent dedication of land to new towers or other aboveground structures; however, new aboveground facilities would likely be constructed in locations where such structures are consistent with local land use regulations. Additionally, once deployment locations are known, site-specific analysis may be required depending on the site conditions, the type of deployment, or any other permits or permissions necessary to perform the work to help ensure environmental concerns are identified. New communication tower projects will also be required to comply with all relevant federal, territorial, and local regulations. In addition, deployment of any infrastructure would need to recognize and avoid or comply with easements established for conservation purposes.

Potential indirect land use and land ownership impacts associated with these two scenarios, along with for the New Build–Buried Fiber Optic Plant, New Build–Submarine Fiber Optic Plant, Installation of Optical Transmission or Centralized Transmission Equipment, and Deployable Technologies options would generally be *less than significant* at the programmatic level. These options would result in temporary disruption associated with deployment, as well as the potential indirect land use and land ownership impacts associated with changing visual conditions (see Section 8.2.7.3, Description of Environmental Concerns); however, these activities would generally be consistent with local land use regulations, and would not result in widespread changes in land use or land ownership patterns.

See Chapter 11, BMPs and Mitigation Measures, for a listing of BMPs and mitigation measures that FirstNet and/or their partners would require, as practicable or feasible, to help further avoid or minimize potential impacts associated with land use and land ownership.

Potential Airspace Impacts

The Construction of New Wireless Communication Towers would permanently affect the use of airspace by potentially creating new aerial navigation hazards, although restricted airspace would likely be avoided. New towers would be required to comply with all relevant federal, territorial, and local regulations regarding siting, lighting, and engineering. The DACA option would add the presence of new manned and unmanned air traffic and/or aerial navigation hazards (in the case of tethered balloons) in Puerto Rico; however, it is likely that only the piloted aircraft option would enter controlled airspace. Because DACA would primarily be used to address wide-scale loss of coverage after a major catastrophic event, such disruptions could be long-term in nature (up to 2 years depending on the emergency). These effects would be *less than significant* at the programmatic level, although BMPs and mitigation measures (see Chapter 11) could help further minimize their potential impacts.

To minimize these effects, FirstNet and/or their partners would likely give preference to development options that do not involve new towers or other tall aboveground structures. For cases where new towers or tall aboveground structures are the preferred option, FirstNet and/or their partners would require, as practicable or feasible, implementation of BMPs and mitigation measures (see Chapter 11).

Other build options would have no airspace impacts because they would not involve aboveground facilities that would intrude into airspace.

Potential Recreational Access and Enjoyment Impacts

None of the FirstNet scenarios would permanently affect access to recreational lands. Deployment of the New Build–Buried Fiber Optic Plant, New Build–Aerial Fiber Optic Plant, New Build–Submarine Fiber Optic Plant, Installation of Optical Transmission or Centralized Transmission Equipment, and New Wireless Communication Towers options could result in temporary blockages of access routes to recreational lands. These blockages would not continue beyond deployment activity. Due to the temporary nature of these deployment scenarios, potential impacts would be *less than significant* at the programmatic level, although BMPs and mitigation measures (Chapter 11) could help further minimize their potential potential impacts.

Potential impacts during deployment of the New Build–Aerial Fiber Optic Plant and New Wireless Communication Towers options could permanently change visual conditions in the vicinity of Puerto Rico's recreation lands. Because such changes could be perceived as adverse, and because adverse perceptions could affect the ability to enjoy recreational activities, deployment of these options could therefore have to some degree a permanent adverse effect on the enjoyment of recreational lands. However, it is anticipated that only minimal or small reductions in visitation or duration of recreational activities would result (as opposed to total loss of enjoyment), if any at all. In addition, the geographic extent of this potential impact would likely be limited to a small number of recreational sites. For these reasons, potential impacts during deployment would be *less than significant* at the programmatic level.

All the development scenarios listed in this subsection, as well as Deployable Technologies, could cause temporary changes to the visual environment due to the presence of vehicles, deployment activities, and construction "scars" where subsurface infrastructure is deployed. Such potential impacts would occur during deployment and until vegetation is able to reclaim affected areas. Accordingly, due to the temporary nature of the deployment activities, these effects would be *less than significant* at the programmatic level and could be further reduced by implementation of BMPs and mitigation measures.

See Chapter 11, BMPs and Mitigation Measures, for a listing of BMPs and mitigation measures that FirstNet and/or their partners would require, as practicable or feasible, to help avoid or minimize potential impacts associated with recreation.

Potential Operation Impacts

As described in Section 2.1.2, Proposed Action Infrastructure, operation activities associated with the Preferred Alternative would consist of routine maintenance and inspection of the facilities. Any major infrastructure replacement as part of ongoing system maintenance would result in potential impacts similar to the abovementioned potential deployment impacts. There would be *no impacts* at the programmatic level to land use, land ownership, use of airspace, access to recreation, or enjoyment of recreation lands associated with routine inspections of the Wired or Wireless options within the Preferred Alternative. As discussed in Section 8.2.8, Visual Resources, nighttime lighting in isolated rural areas or if sited near a national park would be *less than significant with BMPs and mitigation measures incorporated* during operations. FirstNet and/or their partners would work closely with the National Park Service (NPS) to address any concerns they might have if a tower needed to be placed in an area that might affect the nighttime sky at an NPS unit. As discussed above, there would be *less than significant* impacts at the programmatic level for wireless projects that deployed new towers or aboveground structures that do not require lighting. These impacts could be further minimized by implementation of the BMPs and mitigation measures detailed in Chapter 11.

Operation of the Deployable Technologies options of the Preferred Alternative would result in the temporary presence of deployable vehicles and equipment (including airborne equipment), potentially for up to 2 years in some cases. The degree of change in the visual environment (see Section 8.2.8, Visual Resources)—and therefore the potential indirect impact on a landowner’s ability to use or sell of their land as desired—would be highly dependent on the specific deployment location and length of deployment. Nighttime lighting in isolated rural areas or if sited near a national park would be *less than significant with BMPs and mitigation measures incorporated* during operations. Additionally, FirstNet and/or their partners would work closely with the NPS to address any concerns they might have if a tower needed to be placed in an area that might affect the nighttime sky at an NPS unit. The use of DACA could temporarily add new air traffic or aerial navigation hazards, as discussed above. The magnitude of these effects would depend on the specific location of airborne resources along with the duration of their use. However, as operation of all of the Deployable Technology options is to address emergency situations on a temporary basis, the potential impacts are *less than significant* at the programmatic level. BMPs and mitigation measures (see Chapter 11) could further help to avoid or minimize potential impacts.

8.2.7.5. Alternatives Impact Assessment

The following section assesses potential impacts to land use, airspace, and recreation associated with the Deployable Technologies Alternative and the No Action Alternative.[1]

Deployable Technologies Alternative

Under the Deployable Technologies Alternative option, a nationwide fleet of mobile communications systems would provide temporary coverage in areas not covered by the existing, usable infrastructure. There would be no collocation of equipment and no new construction associated with wired or wireless projects discussed above under the Preferred Alternative. Some limited construction could be associated with implementation such as land clearing or paving for parking or staging areas. The specific infrastructure associated with the Deployable Technologies Alternative would be the same as the deployable technologies implemented as part of the Preferred Alternative but would likely be implemented in greater numbers, over a larger geographic extent, and used with greater frequency and duration. Therefore, potential impacts to land use, airspace, and recreation as a result of implementation of this alternative could be as described below.

Potential Deployment Impacts

As explained above, implementation of deployable technologies could result in *less than significant* impacts at the programmatic level to land use if deployment occurs in areas with compatible land uses. While a single deployable technology may have an imperceptible impact, multiple technologies operating in close proximity for longer periods could impact existing and surrounding land uses. There could be impacts to recreation activities during the deployment of technologies if such deployment were to occur within or near designated recreation areas. Enjoyment of activities dependent upon the visibility of wildlife or scenic vistas may be affected. Also, implementation of deployable technologies could result in *less than significant* impacts at the programmatic level to airspace even if deployment does trigger any obstruction criterion or result in changes to flight patterns and airspace restrictions.

Potential Operation Impacts

Operation of deployable technologies would result in land use, land ownership, airspace, and recreation (access and enjoyment) similar in type to those described for the Preferred Alternative. The frequency and extent of those potential impacts would be greater than for the Proposed Action because under this Alternative, deployable technologies would be the only options available. As a result, this alternative would require a larger number of terrestrial and airborne deployable vehicles and a larger number of deployment locations in Puerto Rico—all of which would potentially affect a larger number of properties and/or areas of airspace. It is anticipated that there would be *no impacts* at the programmatic level to land use, recreational resources, or airspace associated with routine inspections assuming the same access roads used for deployment

[1] As mentioned above and in Section 2.1.2, Proposed Action Infrastructure, the Preferred Alternative includes implementation of deployable technologies.

are also used for inspections. Overall these potential impacts would be *less than significant* at the programmatic level due to the minimal footprint associated with the land-based deployable (generally the size of a utility truck). Aerial deployables (manned aircraft, balloons, and drones) would likely use existing airports and facilities for launching and recovery. To further minimize these effects, FirstNet and/or their partners would require, as practicable or feasible, implementation of BMPs and mitigation measures similar to those described for the Preferred Alternative (see Chapter 11).

No Action Alternative

Under the No Action Alternative, the NPSBN would not be deployed; therefore there would be no associated deployment or installation of wired, wireless, deployable infrastructure or satellites and other technologies. As a result, there would be *no impacts* to land use, airspace, and recreational resources because there would be no deployment or operation of the Proposed Action. Land use, airspace, and recreation conditions would therefore be the same as those described in Section 8.1.7, Land Use, Airspace, and Recreation.

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8.2.8. Visual Resources

8.2.8.1. Introduction

This section describes potential impacts to visual resources in Puerto Rico associated with deployment and operation of the Proposed Action. Mitigation measures, as defined through permitting and/or consultation with the appropriate resource agency, would be implemented as part of deployment and operation of the Proposed Action to help avoid or reduce potential impacts to visual resources. Implementation of best management practices (BMPs), as practicable or feasible, could further reduce the potential for impacts. Both mitigation measures and BMPs are discussed in Chapter 11, BMPs and Mitigation Measures.

8.2.8.2. Impact Assessment Methodology and Significance Criteria

The potential impacts of the Proposed Action on visual resources were evaluated using the significance criteria presented in Table 8.2.8-1. As described in Section 8.2, Environmental Consequences, the categories of potential impacts are defined at the programmatic level as *potentially significant*, *less than significant with BMPs and mitigation measures incorporated*, *less than significant*, or *no impact*. Characteristics of each potential impact type, including magnitude or intensity, geographic extent, and duration or frequency, were used to determine the impact significance rating associated with each potential impact.

Given the nature of this programmatic evaluation, and because the Proposed Action could potentially cover a wide variety of actions that would take place in various landscapes, the potential impacts to visual resources addressed in this section are presented as a range of possible impacts.

Table 8.2.8-1: Impact Significance Rating Criteria for Visual Resources

Type of Effect	Effect Characteristic	Impact Level			
		Potentially Significant	**Less than Significant with BMPs and Mitigation Measures Incorporated**	**Less than Significant**	**No Impact**
Adverse change in aesthetic character	Magnitude or Intensity	Fundamental and irreversibly adverse change in aesthetic character	Effect that is *potentially significant*, but with BMPs and mitigation measures is *less than significant* at the programmatic level	Intermittently noticeable adverse change in aesthetic character	No visible effects
	Geographic Extent	Regional impacts observed throughout the state or territory		Effects realized at one or several locations, but not widespread	NA
	Duration or Frequency	Persisting more than 1 year		Persisting 1 month or less	NA
Nighttime lighting	Magnitude or Intensity	Lighting dramatically alters night-sky conditions	Adverse effect that is *potentially significant*, but with BMPs and mitigation measures is *less than significant* at the programmatic level	Lighting alters night-sky conditions to a degree that is noticeable	Lighting does not noticeably alter night-sky conditions
	Geographic Extent	Regional impacts observed throughout the state or territory		Effects realized at one or several locations, but not widespread.	NA
	Duration or Frequency	Persisting more than 1 year		Persisting 1 month or less	NA

NA = not applicable

8.2.8.3. Description of Environmental Concerns

Opinions of and reactions to changes in visual resources are inherently subjective, and are based on each observer's personal feelings about what they are seeing. This Final Programmatic Environmental Impact Statement focuses on cases where changes in the aesthetic environment would occur in or affect lands in Puerto Rico where visual or scenic resources are the subject of adopted regulations, or places where observers are likely to expect higher scenic quality. These lands are discussed in Section 8.1.8, Visual Resources.

Aesthetic Character

Construction and operation of new aboveground facilities, such as new towers, antennae, or other structures, could add new permanent elements to the visual landscape (what observers can readily see from a given vantage point), while construction of options other than aboveground facilities could create temporary changes to the landscape—such as construction scars or the presence of construction equipment. Puerto Rico is known for its scenic quality and attracts tourism in part due to that character; adverse effects to visual resources, including topography and vistas, may be perceived more acutely as a result.

Applicable federal, territory, and local policies and regulations could affect the type and location of new Proposed Action facilities on lands where visual resources are managed through specific policies (such as units of the National Park System) or laws (such as zoning ordinances). Observers are more likely to perceive Proposed Action facilities negatively in or near public or recreational areas, such as local parks, historic neighborhoods, and coastlines. While such preferences are not necessarily codified in law or regulation, observers (especially in a territory like Puerto Rico, which has a reputation for scenic quality) tend to prefer (or even demand) higher levels of scenic quality.

Assets of particular scenic value, wherein adverse effects to vistas and topography may be more acutely noted, include (as described in Section 8.1.8, Visual Resources):

- Segments of the Río de la Mina, Río Icacos, and Río Mameyes designated as national scenic rivers;
- The Luis Muñoz Marin Scenic Route, Puerto Rico's scenic byway, crossing the island from Mayagüez to Maunabo;
- El Yunque National Forest; and
- Six national wildlife refuges, including a proposed scenic road in the Vieques National Wildlife Refuge (*USFWS 2007*).

Proposed Action facilities (especially new towers) that extend above the horizon are also likely to be perceived more negatively than options that remain at or near ground level. In addition, as discussed in Section 8.1.8.2, Specific Regulatory Considerations, the Federal Aviation Administration (FAA) may require certain aboveground structures to be painted white and orange, and in some cases to include daytime lighting (*FAA 2016*). Even for structures that do not extend above the horizon, this paint scheme is likely to contrast with the predominant background, and could thus be perceived negatively.

Finally, as discussed in Section 8.2.9.3, Description of Environmental Concerns, potential real estate purchasers (individuals who wish to purchase a home or property, investors, developers, etc.) and renters could see the presence of aboveground facilities as a negative aesthetic element—a perception that could affect property values. Economists and appraisers have studied this issue and use a statistical analysis methodology known as hedonic pricing (looking at the impact of external factors affecting price), or hedonic modeling, to assess how different attributes of properties such as distance from a tower affect property value (*Bond et al. 2013*). Essentially, analysts compare the value of multiple properties while statistically controlling differences in property attributes, in order to isolate the effect of a specific attribute such as proximity of a communications tower.

A recent literature review examined such studies in the United States, Germany, and New Zealand (*Bond et al. 2013*). These studies all focused on residential properties. One study identified a positive effect on price in one neighborhood due to the presence of a wireless communications tower. Most studies identified negative effects on price. Generally, these negative effects were small: an approximately 2 percent decrease in property price. In one case, the average reduction in price was 15 percent. In all cases, the effects declined rapidly with distance, with some cases showing no effect beyond 100 meters (328 feet) and one case showing effects up to about 300 meters (984 feet).

Nighttime Lighting

As discussed in Section 8.1.8.2, Specific Regulatory Considerations, the FAA requires lighting for a wide variety of aboveground structures including communication towers over 199 feet above ground level (*FAA 2016*). Additionally, structures and facilities associated with the Proposed Action could include ground-level security and safety lighting, although such lighting is not specifically required by the FAA regulations. Although likely very minimal, such lighting would not only constitute a new light source, but could also increase the overall diffusion of artificial light into the sky (commonly referred to as sky glow).

Aside from federal and territory lands where visual resources are managed according to established policies or laws, new nighttime light sources are most likely to be perceived negatively in less developed areas of Puerto Rico (areas away from major cities such as San Juan). In such cases, the new light source may not be able to blend with existing light sources, and would thus potentially be perceived as more distinct.

Nighttime sky glow depends on topography and weather conditions, as well as the number, type, and location of artificial lights. In general, sky glow is associated with larger concentrations of artificial lights (such as a city or neighborhood), rather than a single light source.

8.2.8.4. Potential Impacts of the Preferred Alternative

The following section assesses potential impacts associated with implementation of the Preferred Alternative, including deployment and operation activities. Potential visual impacts of each of the Preferred Alternative options are discussed as a territory-wide system—i.e., the potential collective visual impact of a series of new fiber optic towers, or the potential collective visual impact of a territory-wide system of new wireless receivers installed on existing structures, etc. While this approach could overestimate potential impacts, this is preferable to underestimating potential impacts, as could be the case if the options were evaluated on a structure-by-structure basis.

Potential Deployment Impacts

As described in Section 2.1.2, Proposed Action Infrastructure, implementation of the Preferred Alternative could result in the deployment of various types of facilities or infrastructure. As explained in this section, various types of Preferred Alternative infrastructure could result in a range of *no impacts* to *less than significant* impacts, depending on the deployment scenario or site-specific conditions. Site-specific analysis may be required depending on the site conditions, the type of deployment, or any other permits or permissions necessary to perform the work.

Activities Likely to Have No Impacts

The following types of infrastructure development scenarios or deployment activities that could be part of the Preferred Alternative are likely to have *no impacts* to visual resources at the programmatic level:

- Wired Projects
  - Use of Existing Conduit – New Buried Fiber Optic Plant: Installation of a new buried fiber optic plant within an existing conduit would create visible evidence of construction limited to minor "scars" in the earth at the entry and exit points of the existing conduit, and the presence of construction equipment. These impacts would be minor, temporary, and last only until the area was revegetated. This option would involve no new nighttime lighting.
  - Collocation on Existing Aerial Fiber Optic Plant: While the addition of new aerial fiber optic plant to an existing aerial fiber optic transmission system would likely be visible, the change associated with this option is so small as to be essentially imperceptible. This option would involve no new nighttime lighting, and pole replacement would be limited.
  - Use of Existing Buried or Aerial Fiber Optic Plant or Existing Submarine Cable: Lighting up dark fiber would not have any impacts to visual resources because there would be no ground disturbance. This option would involve no new nighttime lighting.
- Satellites and Other Technologies
  - Satellite-Enabled Devices and Equipment: While new satellite-compatible infrastructure on existing towers, structures, or buildings (where antennae are already placed) would likely be visible, the change associated with this option is so small as to be essentially imperceptible. This option would involve no new nighttime lighting.
  - Deployment of Satellites: FirstNet does not anticipate launching satellites as part of the deployment of the nationwide public safety broadband network (NPSBN); however, it

could include equipment on satellites that are already being launched for other purposes. As adding equipment to an existing launch vehicle would be very unlikely to impact visual resources, it is anticipated that this activity would have *no impact* on those resources.

Activities with the Potential to Have Impacts

Given the scope of the Preferred Alternative, while geographically enormous (in all 50 states, 5 territories, and the District of Columbia), the actual deployment in any one location is unlikely to be extensive and would likely involve a variety of deployment options (including an emphasis on collocations on existing facilities). The specific deployment activity, and where the deployment would take place, would be determined based on location-specific conditions and the results of site-specific environmental reviews. These reviews may be required depending on the site conditions, the type of deployment, or any other permits or permissions necessary to perform the work.

Potential deployment-related impacts to visual resources as a result of implementation of the Preferred Alternative would generally consist of the presence of new aboveground structures (where appropriate), as well as visual evidence of construction and the presence of construction equipment. Potential impacts associated with the Preferred Alternative, based on the deployment activity and the limited duration of construction activities, are described further below. The remainder of this section provides summary impact discussions for each development scenario or deployment activity.

The types of infrastructure development scenarios or deployment activities that could be part of the Preferred Alternative and result in potential impacts to visual resources include the following:

- Wired Projects
  - New Build – Buried Fiber Optic Plant: Installation of a new buried fiber optic plant (i.e., new underground conduit) would create visible evidence of construction, including a “scar” in the earth where the new fiber optic plant was installed, and the presence of construction equipment used for this installation. These “scars” would likely be temporary and last only until the area revegetated. BMPs and mitigation measures could help to avoid or minimize the potential impacts. This option would involve no new nighttime lighting.
  - New Build – Aerial Fiber Optic Plant: The installation of a new aerial fiber optic plant (i.e., new wires on existing and/or new poles) could have a discernable change on aesthetic conditions. This option would add new elements (poles) to the visual environment, and would result in the temporary visible evidence of construction activity and equipment. As it is likely that any new pole placement would take place in established rights-of-way, any potential visual impacts associated with this activity would be temporary and generally unnoticed. BMPs and mitigation measures could help to avoid or minimize potential impacts.

  - New Build – Submarine Fiber Optic Plant: Installation of a new submarine fiber optic plant in nearshore or inland waters would affect visual resources in the vicinity of the onshore landings and any equipment boxes or huts associated with such a cable. Such facilities would represent a change in the visual condition of the shoreline, would create a temporary construction "scar" for the onshore portion of the fiber optic plant, and would involve the presence of construction equipment used for installation. The construction-related aspects of this activity would be temporary while any equipment boxes or huts would be permanent, although generally small in size. BMPs and mitigation measures could help to further avoid or minimize the potential impacts. This option would involve no new nighttime lighting.
  - Installation of Optical Transmission or Centralized Transmission Equipment: Installation of new transmission equipment could add a new element to the visual environment, in the form of a small box or hut. The construction aspects of this activity would be temporary and localized while the new boxes or huts would be permanent, although generally small in size. BMPs and mitigation measures could help to further avoid or minimize the potential impacts. This option would likely involve no new nighttime lighting.
- Wireless Projects
  - New Wireless Communication Towers: Installation of new wireless communication towers would have a discernable change on aesthetic conditions. This option would add new elements (towers) to the visual environment and would result in visible evidence of construction activity and equipment. Depending on specific design, the FAA could require high-visibility paint schemes and/or lighting on the new towers required for this option. BMPs and mitigation measures could help to avoid or minimize potential impacts.
  - Collocation on Existing Wireless Tower, Structure, or Building: While new wireless elements added to existing towers, structures, or buildings (where antennae are already placed) would likely be visible, the change associated with this option is so small as to be essentially imperceptible. However, if the on-site delivery of additional power units, structural hardening, or physical security measures required ground disturbance or removal of vegetation, impacts to the aesthetic character of scenic resources or viewsheds could occur.
- Deployable Technologies (all options)
  - Implementation of deployable technologies could result in potential impacts to visual resources if long-term deployment occurs in scenic areas, or if the implementation requires minor construction of staging or landing areas, or results in vegetation removal, areas of surface disturbance, or additional nighttime lighting.

Potential Aesthetic Character Impacts

Potential visual impacts for the Construction of New Wireless Communication Towers and other build options are expected to be *less than significant* at the programmatic level. FirstNet and/or their partners would require, as practicable or feasible, implementation of the BMPs and mitigation measures listed in Chapter 11, BMPs and Mitigation Measures, to help further minimize potential visual impacts. BMPs and mitigation measures are particularly important if these project types are implemented in more than a few locations—and/or in locations that affect lands where visual resources are regulated—because these options would permanently change views for a variety of observers.

Potential Nighttime Lighting Impacts

Depending on specific design, Construction of New Wireless Communication Towers or Installation of Optical Transmission or Centralized Transmission Equipment options could introduce new artificial lighting, due to FAA regulations or other security concerns. New lighting associated with FirstNet structures could contribute incrementally to sky glow. As a result of the temporary nature of deployment, these effects would be *less than significant* at the programmatic level. See Chapter 11, BMPs and Mitigation Measures, for a listing of BMPs and mitigation measures that FirstNet and/or their partners would require, as practicable or feasible, to help avoid or minimize potential impacts associated with visual resources.

Potential Operation Impacts

As described in Section 2.1.2, Proposed Action Infrastructure, operation activities associated with the Preferred Alternative would consist of routine maintenance and inspection of the facilities. Any major infrastructure replacement as part of ongoing system maintenance would result in potential impacts similar to the abovementioned potential deployment impacts. Wired or wireless options within the Preferred Alternative would have *no impacts* to visual resources at the programmatic level beyond those discussed under Potential Deployment Impacts, above. Nighttime lighting in isolated rural areas or if sited near a National Park would be *less than significant with BMPs and mitigation measures incorporated* during operations. Additionally, FirstNet and/or their partners would work closely with the National Park Service (NPS) to address any concerns they might have if a tower needed to be placed in an area that might affect the nighttime sky at a NPS unit.

Operation of the Deployable Technologies option of the Preferred Alternative would create no permanent changes to the aesthetic environment. Use of these technologies would result in the temporary presence of deployable vehicles and equipment, which would represent a change in existing conditions. The degree of change in the visual environment would be highly dependent on the specific vehicle parking location. Although the FAA would not likely require nighttime lighting for ground-based deployable technologies, some ground-based deployable technologies could include their own safety lighting, which would be visible in the vicinity of the deployable unit. The FAA would likely require nighttime lighting for airborne deployable technologies, such as balloons, blimps, and drones.

8.2.8.5. Alternatives Impact Assessment

The following section assesses potential impacts to socioeconomic resources associated with the Deployable Technologies Alternative and the No Action Alternative.[1]

Deployable Technologies Alternative

Under the Deployable Technologies Alternative option, a nationwide fleet of mobile communications systems would provide temporary coverage in areas not covered by the existing, usable infrastructure. There would be no collocation of equipment and no new construction associated with wired or wireless projects discussed above under the Preferred Alternative. Some limited construction could be associated with implementation such as land clearing or paving for parking or staging areas. The specific infrastructure associated with the Deployable Technologies Alternative would be the same as the deployable technologies implemented as part of the Preferred Alternative but would likely be implemented in greater numbers, over a larger geographic extent, and used with greater frequency and duration. Therefore, potential impacts to visual resources as a result of implementation of this alternative could be as described below. To help minimize these effects, FirstNet and/or their partners would require, as practicable or feasible, the BMPs and mitigation measures for the Proposed Action described in Chapter 11, BMPs and Mitigation Measures.

Potential Deployment Impacts

Deployment (i.e., purchase, staffing, and mobilization) of deployable technologies would generally result in *less than significant* impacts to visual resources at the programmatic level—including aesthetic conditions and nighttime lighting due to the temporary nature of deployment.

Potential Operation Impacts

The potential visual impacts—including aesthetic conditions and nighttime lighting—of the operation of deployable technologies would be *less than significant* at the programmatic level. These potential impacts would be similar to the impacts described for the Deployable Technologies option of the Preferred Alternative, above, only likely with greater numbers of deployable units.

No Action Alternative

Under the No Action Alternative, the NPSBN would not be deployed; therefore there would be no associated construction or installation of wired, wireless, deployable infrastructure or satellites and other technologies. As a result, there would be *no impacts* to visual resources because there would be no construction or operation of the Proposed Action. Visual conditions would therefore be the same as those described in Section 8.1.8, Visual Resources.

[1] As mentioned above and in Section 2.1.2, Proposed Action Infrastructure, the Preferred Alternative includes implementation of deployable technologies.

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8.2.9. Socioeconomics

8.2.9.1. Introduction

This section describes potential impacts to socioeconomics in Puerto Rico associated with deployment and operation of the Proposed Action. Mitigation measures, as defined through permitting and/or consultation with the appropriate resource agency, would be implemented as part of deployment and operation of the Proposed Action to help avoid or reduce potential impacts to socioeconomics. Best management practices (BMPs), as practicable or feasible, would be implemented as part of deployment and operation of the Proposed Action to help avoid or minimize potential adverse impacts, and/or preserve or enhance potential beneficial impacts. Both mitigation measures and BMPs are discussed in Chapter 11, BMPs and Mitigation Measures.

8.2.9.2. Impact Assessment Methodology and Significance Criteria

The potential impacts of the Proposed Action on socioeconomic resources were evaluated using the significance criteria presented in Table 8.2.9-1. As described in Section 8.2, Environmental Consequences, the categories of impacts are defined at the programmatic level as *potentially significant*, *less than significant with BMPs and mitigation measures incorporated*, *less than significant*, or *no impact*. Characteristics of each impact type, including magnitude or intensity, geographic extent, and duration or frequency, were used to determine the impact significance rating associated with each potential impact.

Given the nature of this programmatic evaluation, and because the Proposed Action could potentially cover a wide variety of actions that would take place in various landscapes, the potential impacts to socioeconomic resources addressed in this section are presented as a range of possible impacts.

Table 8.2.9-1: Impact Significance Rating Criteria for Socioeconomics

Type of Effect	Effect Characteristic	Impact Level			
		Potentially Significant	**Less than Significant with BMPs and Mitigation Measures Incorporated**	**Less than Significant**	**No Impact**
Impacts to real estate	Magnitude or Intensity	Change in property values and/or rental fees, constituting a significant market shift	Effect that is *potentially significant*, but with mitigation is *less than significant* at the programmatic level	Indiscernible impact to property values and/or rental fees	No perceptible change in baseline conditions
	Geographic Extent	Regional impacts observed throughout the state or territory		Effects realized at one location	NA
	Duration or Frequency	Persists during or beyond the life of the Proposed Action		Persists for as long as the entire construction phase or a portion of the operations phase	NA
Economic benefits or adverse impacts related to changes in tax revenues, wages, or direct spending (could be beneficial or adverse)	Magnitude or Intensity	Economic change that constitutes a market shift	Adverse effect that is *potentially significant*, but with mitigation is *less than significant* at the programmatic level	Discernible but not substantial economic change	No perceptible change in baseline conditions
	Geographic Extent	Regional impacts observed throughout the state or territory		Effects realized in one city or town	NA
	Duration or Frequency	Persists during or beyond the life of the Proposed Action		Persists for as long as the entire construction phase or a portion of the operations phase	NA
Employment	Magnitude or Intensity	High level of job loss or creation	Effect that is *potentially significant*, but with mitigation is *less than significant* at the programmatic level	Low level of job creation	No perceptible change in baseline conditions
	Geographic Extent	Regional impacts observed throughout the state or territory		Effects realized in one city or town	NA
	Duration or Frequency	Persists during or beyond the life of the Proposed Action		Persists for as long as the entire construction phase or a portion of the operations phase	No perceptible change in baseline conditions

Type of Effect	Effect Characteristic	Impact Level			
		Potentially Significant	**Less than Significant with BMPs and Mitigation Measures Incorporated**	**Less than Significant**	**No Impact**
Increased pressure on existing public services	Magnitude or Intensity	Access to or quality of public services severely constrained, potentially threatening public safety	Effect that is *potentially significant*, but with mitigation is *less than significant* at the programmatic level	Access to or quality of public services constrained to a minimally perceptible degree	No perceptible change in baseline conditions
	Geographic Extent	Regional impacts observed throughout the state or territory		Effects realized at one location	NA
	Duration or Frequency	Persists during or beyond the life of the Proposed Action		Persists for as long as the entire construction phase or a portion of the operations phase	No perceptible change in baseline conditions
Diminished social cohesion / disruption related to influx	Magnitude or Intensity	Impacted individuals and communities cannot adapt to social disruption/ diminished social cohesion, or are not able to adapt fully, even with additional support	Effect that is *potentially significant*, but with mitigation is *less than significant* at the programmatic level	Impacted individuals and communities are able to adapt to social disruption and/or diminished social cohesion without support	No perceptible change in baseline conditions
	Geographic Extent	Regional impacts observed throughout the state or territory		Effects realized at one location	NA
	Duration or Frequency	Persists during or beyond the life of the Proposed Action		Persists for as long as the entire construction phase or a portion of the operations phase	No perceptible change in baseline conditions
Reduced opportunities for subsistence practices	Magnitude or Intensity	Impacted individuals and communities cannot adapt to reduced subsistence opportunities, or are not able to adapt fully, even with additional support	Effect that is *potentially significant*, but with mitigation is *less than significant* at the programmatic level	Impacted individuals and communities are able to adapt to reduced subsistence opportunities without support	No perceptible change in baseline conditions
	Geographic Extent	Regional impacts observed throughout the state or territory		Effects realized at one location	NA
	Duration or Frequency	Persists during or beyond the life of the Proposed Action		Persists for as long as the entire construction phase or a portion of the operations phase	No perceptible change in baseline conditions

NA = not applicable

8.2.9.3. Description of Environmental Concerns

Real Estate

Construction and operation of new aboveground facilities, such as new towers, antennae, or other structures, could affect real estate values. Potential real estate purchasers (individuals who wish to purchase a home or property, investors, developers, etc.) and renters could see the presence of aboveground facilities as a negative aesthetic element, especially in a highly scenic territory such as Puerto Rico (potential visual impacts are discussed in Section 8.2.8, Visual Resources). Purchasers and renters may also believe (regardless of factual information) that the presence of wireless facilities is a negative health impact (potential health impacts are discussed in Section 8.2.15, Human Health and Safety). Such negative perceptions of the Proposed Action could cause purchasers and renters to offer lower payments for affected properties than might otherwise be expected.

Should new land be required for FirstNet buildout (as opposed to installing additional equipment at existing telecommunications sites), such purchases could affect overall real estate markets by reducing the supply of available land. Housing vacancy rates in Puerto Rico are higher than the United States as a whole (see Section 8.1.9, Socioeconomics). As a result FirstNet effects on real estate markets could be stronger than in less land-constrained parts of the nation (i.e., those seeking to purchase or rent a new home would have greater choice in where to purchase). Improvements in telecommunications coverage for first responders in Puerto Rico’s less developed areas could result in increased property value in those areas due to that increased connectivity. Overall effects on real estate would be limited to areas near FirstNet new-build projects rather than the territory as a whole.

Economic Effects (Beneficial and Adverse)

FirstNet deployment and operation could affect the territory’s economy through changes in tax revenue, wages, and spending associated with FirstNet. Such effects could be direct, indirect, or induced. Direct effects could include (but are not limited to) taxes generated by FirstNet facilities, wages paid directly to FirstNet employees (deployment or operations), and FirstNet spending on raw materials. Indirect effects could include, for example, wages paid and materials purchased by FirstNet contractors and subcontractors. Induced effects are those that are not directly related to FirstNet, but that would not occur “but for” FirstNet, such as increased spending at restaurants near construction sites.

New projects such as FirstNet are typically associated with beneficial economic impacts. Potential adverse impacts could occur if the presence of the Proposed Action were to prevent or diminish other existing or likely future economic activity, resulting in reduced taxes, wages, or spending. The same potential visual impacts that could affect real estate in Puerto Rico (see above), could also negatively affect tourist activity in Puerto Rico, which is based at least in part on the territory’s visual characteristics and comprised approximately 3.2 percent of the territory’s gross domestic product in 2013 (*World Bank 2015*).

Employment

FirstNet deployment and operations could create direct, indirect, and induced employment, through new jobs associated with FirstNet (direct), its contractors and subcontractors (indirect), and other businesses that serve FirstNet employees, contractors, or subcontractors (induced). As is the case for economic effects (discussed above), such potential impacts are typically beneficial, but could potentially be adverse if FirstNet deployment or operation results in adverse economic impacts.

The use of Puerto Rico-resident employees for FirstNet projects in Puerto Rico is an important consideration. Residents are more likely to spend their wages in the territory, driving economic activity (discussed above) while reducing potential adverse impacts on social cohesion (see below).

Increased Pressure on Public Services

The use of public services, such as first responders (police, fire, etc.), public utilities, and public schools, is typically tied to Proposed Action-related changes in residential population and employment. Increased population and/or employment typically results in increased demand for services. Increased demand for services could be offset by increased tax revenue (see Economic Effects subsection, above, as well as Section 8.2.1, Infrastructure).

Diminished Social Cohesion and/or Disruption due to Influx

While Puerto Rico has a diverse and skilled labor market, construction projects such as FirstNet could result in the influx of construction and operations workers into the Proposed Action area to the extent that labor outside of the immediate, local area is used. Social tension between existing residents and newly arrived workers could result from a variety of sources, such as dissatisfaction among existing residents who did not receive Proposed Action-related jobs, cultural differences between existing residents and new workers, and inappropriate or illegal behavior by incoming workers (e.g., alcohol and drug abuse, or solicitation of prostitution), many of whom are men without families, or whose families have not relocated with them. Puerto Rico's physical separation from the mainland United States (and other nations) reduces, but does not eliminate, the possibility of such influx.

Reduced Opportunities for Subsistence Practices

FirstNet's physical footprint and deployment activities could reduce the land available for subsistence activities, and/or could diminish the availability of subsistence species. The cultural aspects of subsistence practices in Puerto Rico are discussed in Section 8.1.11, Cultural Resources.

8.2.9.4. Potential Impacts of the Preferred Alternative

The following section assesses potential impacts associated with implementation of the Preferred Alternative, including deployment and operation activities.

Potential Deployment Impacts

As described in Section 2.1.2, Proposed Action Infrastructure, implementation of the Preferred Alternative could result in the deployment of various types of facilities or infrastructure. As explained in this section, the various types of Preferred Alternative infrastructure could result in a range of *no impacts* to *less than significant* impacts at the programmatic level, depending on the deployment scenario or site-specific conditions. Site-specific analysis may be required depending on the site conditions, the type of deployment, or any other permits or permissions necessary to perform the work.

Activities Likely to Have No Impacts

Of the types of facilities or infrastructure development scenarios described in Section 2.1.2, Proposed Action Infrastructure, the following is likely to have *no impacts* to socioeconomics at the programmatic level:

- Satellites and Other Technologies
  - Deployment of Satellites: FirstNet does not anticipate launching satellites as part of the deployment of the nationwide public safety broadband network (NPSBN); however, it could include equipment on satellites that are already being launched for other purposes. As adding equipment to an existing launch vehicle would be very unlikely to impact socioeconomic resources at the territory level, it is anticipated that this activity would have *no impact* to those resources.

Activities with the Potential to Have Impacts

Potential deployment-related impacts to socioeconomic resources as a result of implementation of the Preferred Alternative would encompass a range of potential impacts that could occur as a result of new employment and/or economic activity, as well as potential effects on real estate, public services, subsistence, and social cohesion. The remainder of this section provides summary potential impact discussions for each development scenario or deployment activity.

- Wired Projects:
  - New Build – Buried Fiber Optic Plant: Installation of a new buried fiber optic plant (i.e., new underground conduit) would create no permanent change in factors affecting perceived property values (aesthetics, health, and safety). There could be potentially discernable benefits to the economy (increased property, income, and sales tax revenues) and employment. The influx of new workers could affect the social cohesion of a given area, but could be dependent on whether the workers are Puerto Rico residents or not. BMPs and mitigation measures (see Chapter 11, BMPs and Mitigation Measures) could further help to minimize potential impacts.
  - Use of Existing Conduit – New Buried Fiber Optic Plant: Installation of a new buried fiber optic plant within an existing conduit would create no permanent change in factors affecting perceived property values (aesthetics, health, and safety). There could be potentially discernable benefits to the economy (increased property, income, and sales tax

revenues) and employment. The influx of new workers could affect the social cohesion of a given area, but could be dependent on whether the workers are Puerto Rico residents or not. BMPs and mitigation measures (see Chapter 11, BMPs and Mitigation Measures) could help to further minimize potential impacts. The effects described above would be similar to but less than the New Build – Buried Fiber Optic Plant option, because the Use of Existing Conduit – New Buried Fiber Optic Plant option would involve less ground disturbance, and therefore less labor and use of equipment.

- New Build – Aerial Fiber Optic Plant: The installation of a new aerial fiber optic plant (i.e., new wires on elevated structures) could potentially have a discernable change for factors that affect perceived property values (aesthetics, health, and safety). To the degree that such changes reduce property values, these effects could also reduce tax revenues, an adverse economic effect. BMPs and mitigation measures (see Chapter 11, BMPs and Mitigation Measures) could help to further minimize potential impacts. There could be potentially discernable benefits to the economy (increased property, income, and sales tax revenues) and employment. The influx of new workers could affect the social cohesion of a given area, but could be dependent on whether the workers are Puerto Rican or not. BMPs and mitigation measures (see Chapter 11, BMPs and Mitigation Measures) could help to further minimize potential impacts.
- Collocation on Existing Aerial Fiber Optic Plant: Collocation of new aerial fiber optic plant with existing fiber optic plant would create no permanent change in factors affecting perceived property values (aesthetics, health, and safety) or subsistence resources. There could be potentially discernable benefits to the economy (increased property, income, and sales tax revenues) and employment. The influx of new workers could affect the social cohesion of a given area, but could be dependent on whether the workers are Puerto Rico residents or not. BMPs and mitigation measures (see Chapter 11, BMPs and Mitigation Measures) could help to further minimize potential impacts.
- Use of Existing Buried or Aerial Fiber Optic Plant or Existing Submarine Cable: The use of existing fiber optic plant would create no permanent change in factors affecting perceived property values (aesthetics, health, and safety) or subsistence resources. There could be some potentially discernable benefits to the economy (increased property, income, and sales tax revenues) and employment. The influx of new workers could affect the social cohesion of a given area, but could be dependent on whether the workers are Puerto Rico residents or not. BMPs and mitigation measures (see Chapter 11, BMPs and Mitigation Measures) could further help to minimize potential impacts. The effects described above would be similar to but less than those described for the Collocation on Existing Aerial Fiber Optic Plant option, and substantially less than the new build options.
- New Build – Submarine Fiber Optic Plant: Installation of a new submarine fiber optic plant in limited near-shore or inland waters would create no permanent change in factors affecting perceived property values (aesthetics, health, and safety). There could be

potentially discernable benefits to the economy (increased property, income, and sales tax revenues) and employment. The influx of new workers could affect the social cohesion of a given area, but could be dependent on whether the workers are Puerto Rico residents or not. BMPs and mitigation measures (see Chapter 11, BMPs and Mitigation Measures) could help to further minimize potential impacts.

  - Installation of Optical Transmission or Centralized Transmission Equipment: Installation of new transmission equipment could potentially have a discernable change in factors that affect perceived property values—particularly aesthetics due to new access roads. To the degree that such changes reduce property values, these effects could also reduce tax revenues, an adverse economic effect. There could be potentially discernable benefits to the economy (increased property, income, and sales tax revenues) and employment. The influx of new workers could affect the social cohesion of a given area, but could be dependent on whether the workers are Puerto Rico residents or not. BMPs and mitigation measures (see Chapter 11, BMPs and Mitigation Measures) could help to further minimize potential impacts. The effects described above would be similar to but less than those described for the New Build – Buried Fiber Optic Plant, because the Use of Existing Buried or Aerial Fiber Optic Plant or Existing Submarine Cable option would involve less ground disturbance, and therefore less labor and use of equipment.

- Wireless Projects
  - New Wireless Communication Towers: Installation of new wireless communication towers could potentially have a discernable change for factors that affect perceived property values (aesthetics, health, and safety). To the degree that such changes reduce property values, these effects could also reduce tax revenues, an adverse economic effect. There could be potentially discernable benefits to the economy (income and sales tax revenues) and employment. The influx of new workers could affect the social cohesion of a given area, but could be dependent on whether the workers are Puerto Rico residents or not. In addition, and depending on location, installation of new wireless communication towers could affect terrestrial subsistence resources given FirstNet's physical footprint and deployment activities, either through diminishment of habitat or through the interruption of migratory pathways. BMPs and mitigation measures (see Chapter 11, BMPs and Mitigation Measures) could help to further minimize potential impacts.
  - Collocation on Existing Wireless Tower, Structure, or Building. The collocation of new wireless facilities on existing facilities would create no permanent change in factors affecting perceived property values (aesthetics, health, and safety) or subsistence resources. There could be some potentially discernable benefits to the economy (increased property, income, and sales tax revenues) and employment. The influx of new workers could affect the social cohesion of a given area, but could be dependent on whether the workers are Puerto Rico residents or not. BMPs and mitigation measures (see Chapter 11, BMPs and Mitigation Measures) could help to further minimize potential impacts. The effects described above would be similar to but less than those

described for the Collocation on Existing Aerial Fiber Optic Plant option, and substantially less than the new build options.

- Deployable Technologies (all options)
  - The use of deployable technologies, including some limited construction associated with implementation, such as land clearing or paving for parking or staging areas, could create no permanent changes to factors that affect perceived property values (aesthetics, health, and safety). There could be potentially discernable benefits to the economy (increased property, income, and sales tax revenues) and employment. The influx of new workers could affect the social cohesion of a given area, but would be dependent on whether the workers are Puerto Rico residents or not. BMPs and mitigation measures (see Chapter 11, BMPs and Mitigation Measures) could help to further minimize potential impacts.
- Satellite and Other Technologies
  - Satellite-Enabled Devices and Equipment: The installation of new satellite-compatible infrastructure would create no permanent change in factors affecting perceived property values (aesthetics, health, and safety) or subsistence resources. There could be potentially discernable benefits to the economy (increased property, income, and sales tax revenues) and employment. The influx of new workers could affect the social cohesion of a given area, but could be dependent on whether the workers are Puerto Rico residents or not. The effects described above would be similar to but less than those described for the Collocation on Existing Aerial Fiber Optic Plant option, and substantially less than the new build options. BMPs and mitigation measures (see Chapter 11, BMPs and Mitigation Measures) could help to further minimize potential impacts. The use of satellite-compatible devices (e.g., mobile phones) absent the installation of new equipment would have *no impacts*.

Potential Real Estate Impacts

Potential real estate impacts for the New Build – Aerial Fiber Optic Plant and Construction of New Wireless Communication Towers option and the Installation of Optical Transmission or Centralized Transmission Equipment option would be *less than significant* at the programmatic level. These options could permanently change views from private property and/or introduce new wireless infrastructure that property buyers or renters could perceive as having impacts; however, these potential impacts would be temporary and only as long as the construction period lasted. Economists and appraisers have studied this issue and use a statistical analysis methodology known as hedonic pricing (looking at the impact of external factors effecting price), or hedonic modelling, to assess how different attributes of properties such as distance from a tower affect property value (*Bond et al. 2013)*. Essentially, analysts compare the value of multiple properties while statistically controlling for differences in property attributes, in order to isolate the effect of a specific attribute such as, proximity of a communications tower.

A recent literature review examined such studies in the United States, Germany, and New Zealand (*Bond et al. 2013*). These studies all focused on residential properties. One study identified a beneficial effect on price in one neighborhood due to the presence of a wireless communications tower. Most studies identified adverse effects on price. Generally, these adverse effects were small: an approximately two percent decrease in property price. In one case, the average reduction in price was 15 percent. In all cases, the effects declined rapidly with distance, with some cases showing no effect beyond 100 meters (328 feet) and one case showing effects up to about 300 meters (984 feet).

See Chapter 11, BMPs and Mitigation Measures, for a listing of BMPs and mitigation measures that FirstNet and/or their partners would require, as practicable or feasible, to further avoid or minimize potential real estate impacts.

Potential Economic Impacts

To the degree that the New Build – Aerial Fiber Optic Plant and Construction of New Wireless Communication Towers or Installation of Optical Transmission or Centralized Transmission Equipment options reduce property values and, although anticipated to be minor, these options could also reduce tax revenues. Other options would not reduce property values, and would therefore not affect tax revenues. Additionally, construction activity associated with FirstNet deployment could create additional wages, spending, and/or tax revenues. To further minimize potential negative effects on real estate or taxes, FirstNet and/or their partners would require, as practicable or feasible, implementation of the BMPs and mitigation measures described in Chapter 11, BMPs and Mitigation Measures.

Overall, the potential economic impacts from Preferred Alternative development options would likely be beneficial and *less than significant* at the programmatic level. BMPs and mitigation measures described in Chapter 11, BMPs and Mitigation Measures, could maintain or enhance these likely beneficial economic impacts.

Potential Employment Impacts

The potential employment impacts from Preferred Alternative development options would likely be beneficial and *less than significant* at the programmatic level. Construction activity associated with FirstNet deployment could create additional jobs (through new jobs directly associated with FirstNet, its contractors and subcontractors, and other business that serve FirstNet employees, contractors, or subcontractors). See Chapter 11, BMPs and Mitigation Measures, for a listing of BMPs and mitigation measures that FirstNet and/or their partners would require, as practicable or feasible, to enhance these benefits.

Potential Public Services Impacts

Potential impacts on demand for public services would be *less than significant* at the programmatic level. As mentioned above, the use of public services is typically tied to changes in residential population and employment. Increases in population and/or employment typically results in increased demand for services, however, this demand is anticipated to be minimal. See Chapter 11, BMPs and Mitigation Measures, for a listing of BMPs and mitigation measures that FirstNet and/or their partners would require, as practicable or feasible, to further minimize potential public services impacts.

Potential Social Cohesion Impacts

Potential social cohesion impacts, due to the potential influx of workers into the project areas, are anticipated to be *less than significant* at the programmatic level for Preferred Alternative development options primarily due to the limited amount of construction activities in any one area. To further minimize potential social cohesion impacts, FirstNet and/or their partners would, as practicable or feasible, likely give preference to hiring workers who are residents of Puerto Rico, and ideally of the island on which construction activities would take place (see Chapter 11, BMPs and Mitigation Measures).

Potential Subsistence Impacts

There could be a potential to cause minor damage, remove access to, or cause the relocation of plant and animal species important for subsistence activities. However, given the limited amount of construction anticipated in any one area, it is anticipated that this potential impact would be minimal. Therefore, potential subsistence impacts are anticipated to be *less than significant* at the programmatic level for the Preferred Alternative.

These minimal potential impacts could be further reduced by implementing the BMPs and mitigation measures that FirstNet and/or their partners would require, as practicable or feasible, to further avoid or minimize potential impacts to subsistence harvesting[1] (see Chapter 11, BMPs and Mitigation Measures).

Potential Operation Impacts

As described in Section 2.1.2, Proposed Action Infrastructure, operation activities associated with the Preferred Alternative would consist of routine maintenance and inspection of the facilities. Any major infrastructure replacement as part of ongoing system maintenance would result in potential impacts similar to the abovementioned potential deployment impacts. There would be *less than significant* impacts to real estate public services, social cohesion, and subsistence resources at the programmatic level and likely minimal but beneficial *less than significant* impacts to economic activity and employment associated with routine inspections of the Preferred Alternative at the programmatic level. It is possible that minor adverse employment impacts could occur from temporary dislocations or job loss at local broadband service providers, should commercial broadband services be offered by FirstNet's partners that result in a loss of business at local providers; however, such employment losses would be expected to be at least partly offset by employment gains from the Preferred Alternative.

8.2.9.5. Alternatives Impact Assessment

The following section assesses potential impacts to socioeconomic resources associated with the Deployable Technologies Alternative and the No Action Alternative.[2]

[1] Harvesting is the act or process to take or kill wildlife for food, sport, or population control; or to gather crops for consumption.
[2] As mentioned above and in Section 2.1.2, Proposed Action Infrastructure, the Preferred Alternative includes implementation of deployable technologies.

Deployable Technologies Alternative

Under the Deployable Technologies Alternative option, a nationwide fleet of mobile communications systems would provide temporary coverage in areas not covered by the existing, usable infrastructure. There would be no collocation of equipment and no new construction associated with wired or wireless projects discussed above under the Preferred Alternative. Some limited construction could be associated with implementation such as land clearing or paving for parking or staging areas. The specific infrastructure associated with the Deployable Technologies Alternative would be the same as the deployable technologies implemented as part of the Preferred Alternative but would likely be implemented in greater numbers, over a larger geographic extent, and used with greater frequency and duration. Therefore, potential impacts to socioeconomic resources as a result of implementation of this alternative could be as described below.

Potential Deployment Impacts

Deployment (i.e., purchase and staffing) of deployable technologies would result in *no impacts* to real estate, public services, social cohesion, and subsistence. Impacts on economic activity and employment due to the employees who operate deployable equipment, the wages paid to them, and the expenditures on equipment, fuel, and other items would likely be beneficial and *less than significant*.

Potential Operation Impacts

Operation of deployable technologies would result in *no impacts* to public services or social cohesion, and *less than significant* impacts to real estate and subsistence resources if deployment locations are in areas where subsistence resources are present, and if the same deployment locations are used repeatedly and frequently. Implementation of deployable technologies would likely have *less than significant* beneficial impacts on economic activity and employment due to the employees who operate deployable equipment, the wages paid to them, and the expenditures on equipment, fuel, and other items.

No Action Alternative

Under the No Action Alternative, the NPSBN would not be deployed; therefore, there would be no associated construction or installation of wired, wireless, deployable infrastructure or satellites and other technologies. As a result, there would be *no impacts* to socioeconomic resources because there would be no deployment or operation of the Proposed Action. Socioeconomic conditions would therefore be the same as those described in Section 8.1.9, Socioeconomics.

8.2.10. Environmental Justice

8.2.10.1. Introduction

This section describes the potential impacts to environmental justice in Puerto Rico associated with deployment and operation of the Proposed Action.[1] Mitigation measures, as defined through permitting and/or consultation with the appropriate resource agency, would be implemented as part of deployment and operation of the Proposed Action to help avoid or reduce potential impacts to environmental justice. Implementation of best management practices (BMPs), as practicable or feasible, could further reduce the potential for impacts. Both mitigation measures and BMPs are discussed in Chapter 11, BMPs and Mitigation Measures.

8.2.10.2. Impact Assessment Methodology and Significance Criteria

Construction and operation of the Proposed Action in Puerto Rico could generate a potential environmental justice impact if high and adverse health and/or environmental impacts resulting from any phase of the Proposed Action's deployment or operation were to disproportionately affect a minority or low-income group (see below). If the impacts on the general population are not significant (in other words, are not high and adverse), there can be no disproportionate impacts on minority and low-income populations. For impacts determined to be significant, disproportionality would be determined based on the minority and low-income status of the population in the affected area. The significance of potential impacts of the Proposed Action on environmental justice was evaluated using the significance criteria presented in Table 8.2.10-1. As described in Section 8.2, Environmental Consequences, the categories of potential impacts are defined at the programmatic level as *potentially significant*, *less than significant with BMPs and mitigation measures incorporated*, *less than significant*, or *no impact*. Characteristics of each impact type, including magnitude or intensity, geographic extent, and duration or frequency, were used to determine the impact significance rating associated with each potential impact.

Given the nature of this programmatic evaluation, and because the Proposed Action could potentially cover a wide variety of actions that would take place in various areas, the potential impacts to environmental justice addressed in this section are presented as a range of possible impacts.

[1] A discussion of impacts to subsistence practices or resources as a result of deployment and operation of the Proposed Action is included in Section 8.2.9, Socioeconomics.

Table 8.2.10-1: Impact Significance Rating Criteria for Environmental Justice

Type of Effect	Effect Characteristic	Impact Level			
		Potentially Significant	**Less than Significant with BMPs and Mitigation Measures Incorporated**	**Less than Significant**	**No Impact**
Effects associated with other resource areas (e.g., cultural resources) that have environmental justice implications due to the affected parties (as defined by EO 12898)	Magnitude or Intensity	Direct and disproportionate effects on environmental justice communities (as defined by EO 12898) that cannot be fully mitigated	Effect that is *potentially significant*, but with mitigation is *less than significant* at the programmatic level	Direct effects on environmental justice communities (as defined by EO 12898) that do not require mitigation	No perceptible change in baseline conditions
	Geographic Extent	Regional impacts observed throughout the state or territory		Effects realized at one location as opposed to throughout the state or territory	NA
	Duration or Frequency	Persists during or beyond the life of the Proposed Action		Persists for as long as the entire construction phase or a portion of the operations phase	NA

EO = Executive Order; NA = not applicable

8.2.10.3. Description of Environmental Concerns

As described in Section 2.1.2, Proposed Action Infrastructure, implementation of the Preferred Alternative could result in the deployment of various types of facilities or infrastructure. Depending on the location of the facility/infrastructure and the specific deployment requirements, some activities could result in potential impacts to environmental justice communities and others would not. As explained in this section, the various types of Proposed Action infrastructure could result in impacts ranging from *no impact* to *less than significant* at the programmatic level, depending on the deployment scenario or site-specific conditions.[2] Section 8.1.10.4, Identification of Potential for Environmental Justice Impacts, shows areas in Puerto Rico with high, moderate, and low potential for environmental justice impacts.

8.2.10.4. Potential Impacts of Preferred Alternative

The following section assesses potential environmental justice impacts associated with implementation of the Preferred Alternative, including deployment and operation activities.

Potential Deployment Impacts

The determination of potential environmental justice impacts is dependent on both the specific location of deployment and operation as well as the magnitude of impacts to other resources and the types of resources affected. Environmental justice impacts are more likely to occur as a result of significant impacts to soils, water resources, land use, visual resources, socioeconomics, cultural resources, air quality, noise, biological resources, and human health and safety, to the extent those impacts occur.

Activities Likely to Have No Impacts

The types of infrastructure development scenarios or deployment activities that could be part of the Preferred Alternative and that are likely to have *no impact* on environmental justice at the programmatic level include the following:

- Wired Projects
  - Use of Existing Conduit – New Buried Fiber Optic Plant: Disturbance associated with the installation of fiber optic cable in existing conduit would be limited to entry and exit points of the existing conduit in previously disturbed areas. It is anticipated that there would be *no impacts* to environmental justice communities because the activities that would be conducted at these small entry and exit points are not likely to produce perceptible surface disturbances. Additionally, installation of a new buried fiber optic plant within an existing conduit could lead to minor beneficial economic and employment benefits.

[2] Since potential environmental justice impacts occur at the site-specific level, analyses of individual proposed projects would be required to determine potential impacts to specific environmental justice communities. Site-specific analysis may be required depending on the site conditions, the type of deployment, or any other permits or permissions necessary to perform the work. In addition, BMPs and mitigation measures may be required to address potential impacts to environmental justice communities at the site-specific level.

- Use of Existing Buried or Aerial Fiber Optic Plant or Existing Submarine Cable: The use of existing fiber optic plant would involve minimal aboveground activity in Puerto Rico. While some socioeconomic impacts could occur (see Section 8.2.9, Socioeconomics), it is unlikely that any of these impacts would rise to the level of "high and adverse" necessary to create environmental justice effects at the programmatic level.

- Satellites and Other Technologies
  - Satellite-Enabled Devices and Equipment: The installation of new satellite-compatible infrastructure could lead to economic benefits, and would create no permanent adverse changes in factors that affect environmental justice (such as income, economic conditions, population distribution, and subsistence, among others). The use of satellite-compatible devices (e.g., mobile phones) absent the installation of new equipment would have *no impacts*. BMPs and mitigation measures could help to avoid or minimize the potential impacts.
  - Deployment of Satellites: FirstNet does not anticipate launching satellites as part of the deployment of the nationwide public safety broadband network (NPSBN); however, it could include equipment on satellites that are already being launched for other purposes. As adding equipment to an existing launch vehicle would be very unlikely to impact environmental justice communities, it is anticipated that this activity would have *no impact* to those resources.

Activities with the Potential to Have Impacts

Given the scope of the Preferred Alternative, while geographically enormous (in total 50 states, 5 territories, and the District of Columbia), the actual deployment in any one location is unlikely to be extensive and would likely involve a variety of deployment options (including an emphasis on collocations on existing facilities). The specific deployment activity and where the deployment would take place would be determined based on location-specific conditions and the results of site-specific environmental reviews. Site specific analysis may be required depending on the site conditions, the type of deployment, or any other permits or permissions necessary to perform the work.

Except for the four infrastructure development activities described above, all development scenarios and deployment activities have at least some potential to create environmental justice impacts. Taking into account the limited duration of construction activities, the types of infrastructure development scenarios or deployment activities that could be part of the Preferred Alternative and result in potential environmental justice impacts are discussed below. In general, as described in Section 8.2.10.2, Impact Assessment Methodology and Significance Criteria, environmental justice impacts could occur as a result of other impacts (such as to air, water, or socioeconomics, etc.); the Potential for environmental justice impacts shown in Figure 8.1.10-1 (in the Affected Environment section) indicates the degree to which such resource-specific impacts could disproportionately and adversely affect environmental justice communities. These potential impacts associated with the Preferred Alternative, based on the deployment activity and the limited duration of construction activities, are described further below.

- Wired Projects
  - New Build – Buried Fiber Optic Plant: Installation of a new buried fiber optic plant (i.e., new underground conduit) could lead to economic and employment benefits, but could have adverse effects on land, air, water, community cohesion (due to worker influx), and other resources. BMPs and mitigation measures could help to avoid or minimize these potential impacts.
  - New Build – Aerial Fiber Optic Plant: The installation of a new aerial fiber optic plant (i.e., new wires on elevated structures) could lead to economic and employment benefits, but could have adverse effects on land, air, community cohesion (due to worker influx), and other resources. BMPs and mitigation measures could help to avoid or minimize these potential impacts.
  - Collocation on Existing Aerial Fiber Optic Plant: Collocation of new aerial fiber optic plant with existing fiber optic plant could lead to economic and employment benefits, although these would be less than the New Build – Aerial Fiber Optic Plant option. While this option could affect land, air, and water resources, such potential impacts are less likely than under the New Build – Aerial Fiber Optic Plant option because collocations on Existing Aerial Fiber Optic Plants would involve less ground disturbance compared to the build-out of new infrastructure. BMPs and mitigation measures could help to further avoid or minimize these potential impacts.
  - New Build – Submarine Fiber Optic Plant: Installation of a new submarine fiber optic cable in limited near-shore or inland bodies of water could lead to economic and employment benefits, but could have adverse effects on land, air, water, community cohesion (due to worker influx), and other resources. BMPs and mitigation measures could help to avoid or minimize these potential impacts.
  - Installation of Optical Transmission or Centralized Transmission Equipment: Installation of new transmission equipment could lead to economic and employment benefits, but could have adverse effects on land, air, water, community cohesion (due to worker influx), and other resources, due in part to the need to create access roads. BMPs and mitigation measures could help to avoid or minimize these potential impacts.
- Wireless Projects
  - New Wireless Communication Towers: Installation of new wireless communication towers could lead to economic and employment benefits, but could have adverse effects on land, air, water, community cohesion (due to worker influx), and other resources. In addition, and depending on location, installation of new wireless communication towers could result in limited and isolated impacts to some terrestrial subsistence resources, either through diminishment of habitat or through the interruption of migratory pathways. However, given the relatively small footprint of this project type, potential impacts, if any, would likely be localized (not widespread). BMPs and mitigation measures (see Chapter 11, BMPs and Mitigation Measures) could help to avoid or minimize these potential impacts.

  - Collocation on Existing Wireless Tower, Structure, or Building: Collocation would include mounting or installing equipment (such as antennas) on an existing facility. This activity would be small in scale, temporary, and highly unlikely to produce adverse human health or environmental impacts on the surrounding community. Thus, it would not impact environmental justice communities. If collocation requires construction for additional power units, structural hardening, and physical security measures, the construction activity could temporarily generate noise and dust and disrupt traffic. If these effects occur disproportionately in environmental justice communities, they would be considered environmental justice impacts.
- Deployable Technologies (all options)
  - Deployable Technologies: Cell on Wheels, Cell on Light Truck, System on Wheels, and aerial deployable technologies require storage, staging, and (for aerial deployables) launch and landing areas. To the extent such areas require new construction, noise and dust could be generated temporarily, and traffic could be disrupted. If these effects occur disproportionately in environmental justice communities, they would be considered environmental justice impacts.

As described in this Final Programmatic Environmental Impact Statement, none of the development scenarios or deployment activities would result in significant impacts after mitigation. As a result, there would likely be no disproportionately high and adverse effects to environmental justice communities in Puerto Rico at the programmatic level from any development scenario or deployment activity and even less potential impact if BMPs mitigation measures are followed.

Potential Environmental Justice Impacts

Potential environmental justice impacts from all development scenarios and activities (except for the Use of Existing Conduit – New Buried Fiber Optic Plant, Use of Existing Buried or Aerial Fiber Optic Plant or Existing Submarine Cable, Satellite Enabled Devices and Equipment, or Deployment of Satellites options, which would have *no impacts* at the programmatic level) would be *less than significant* at the programmatic level. In general, the impacts from the abovementioned activities would be short-term and could potentially involve objectionable dust, noise, traffic, or other localized impacts due to construction activities. In some cases, these effects as well as aesthetic effects could potentially impact property values, particularly for new towers. Since environmental justice impacts occur at the site-specific level, analyses of individual proposed projects would help determine potential impacts to specific environmental justice communities. Site specific analysis may be required depending on the site conditions, the type of deployment, or any other permits or permissions necessary to perform the work. BMPs and mitigation measures may be required to address potential impacts to environmental justice communities at the site-specific level. See Chapter 11, BMPs and Mitigation Measures, for a listing of BMPs and mitigation measures that FirstNet and/or their partners would require, as practicable or feasible, to help avoid or minimize potential impacts associated with environmental justice.

Potential Operation Impacts

As described in Section 2.1.2, Proposed Action Infrastructure, operation activities associated with the Preferred Alternative, which would consist of routine maintenance and inspection of the facilities, are anticipated to have *less than significant* impacts at the programmatic level if the same roads are used to perform inspections and maintenance activities. Any major infrastructure replacement as part of ongoing system maintenance would result in potential impacts similar to the deployment impacts described above.

8.2.10.5. Alternatives Impact Assessment

This section discusses potential environmental justice impacts associated with the Deployable Technologies Alternative and the No Action Alternative.

Deployable Technologies Alternative

Under the Deployable Technologies Alternative, a nationwide fleet of mobile communications systems would provide temporary coverage in areas not covered by the existing, usable infrastructure. There would be no collocation of equipment and no new construction associated with wired or wireless projects discussed above under the Preferred Alternative. In general, some limited construction could be associated with the implementation of deployable technologies such as land clearing or paving for parking or staging areas. However, these construction activities would be minimal in comparison to the combination of project types associated with the Preferred Alternative as described above. The specific infrastructure associated with the Deployable Technologies Alternative would be the same as the deployable technologies implemented as part of the Preferred Alternative, but would likely be implemented in greater numbers, over a larger geographic extent, and used with greater frequency and duration.

The potential for environmental justice impacts shown in Figure 8.1.10-1 is applicable to this alternative.

Potential Deployment Impacts

As explained above, deployable technologies such as Cell on Wheels, Cell on Light Truck, and System on Wheels, along with aerial deployable technologies, could require storage, staging, and launch/landing areas. To the extent such areas require new construction, noise and dust could be generated temporarily, and traffic could be disrupted. These impacts are expected to be *less than significant* at the programmatic level. If these effects occur disproportionately in environmental justice communities, they would be considered environmental justice impacts.

Potential Operation Impacts

Operation of deployable technologies would result in effects similar in type to, but more frequent than, those described for the Preferred Alternative. As a result, the Deployable Technologies Alternative would result in *less than significant* disproportionate impacts to environmental justice communities at the programmatic level due to the impacts to air, water, land, and subsistence resources associated with the operation of deployable vehicles for up to 2 years at a time. The BMPs and mitigation measures described for the Preferred Alternative could help to minimize these impacts. Implementation of deployable technologies would likely have *less than significant* beneficial impacts on environmental justice communities at the programmatic level due to the employees who operate deployable equipment, the wages paid to them, and the expenditures on equipment, fuel, and other items (see Section 8.2.9, Socioeconomics).

No Action Alternative

Under the No Action Alternative, the NPSBN would not be deployed. As a result, there would be *no impacts* to Environmental Justice communities because there would be no deployment or operation of the Proposed Action. There would be no environmental justice impacts associated with the No Action Alternative.

8.2.11. Cultural Resources

8.2.11.1. Introduction

This section describes potential impacts to cultural resources in Puerto Rico associated with deployment and operation of the Proposed Action. Mitigation measures, as defined through permitting and/or consultation with the appropriate resource agency, would be implemented as part of deployment and operation of the Proposed Action to help avoid or reduce potential impacts to cultural resources. Implementation of best management practices (BMPs), as practicable or feasible, could further reduce the potential for impacts. Both mitigation measures and BMPs are discussed in Chapter 11, BMPs and Mitigation Measures.

8.2.11.2. Impact Assessment Methodology and Significance Criteria

The impacts of the Proposed Action on cultural resources were evaluated using the significance criteria presented in Table 8.2.11-1. As described in Section 8.2, Environmental Consequences, the categories of impact ratings are defined as *adverse effect; mitigated adverse effect; effect, but not adverse;* and *no effect*. These impact categories are comparable to those defined in *36 CFR § 800*, Secretary of Interior's Standards and Guidelines for Archaeology and Historic Preservation (*NPS 1983*), and the United States (U.S.) National Park Service's *National Register Bulletin: How to Apply the National Register Criteria for Evaluation* (*NPS 2002*). Characteristics of each impact type, including magnitude or intensity, geographic extent, and duration or frequency, were used to determine the impact significance rating associated with each potential impact.

Given the nature of this programmatic evaluation, and because the Proposed Action could potentially cover a wide variety of actions that would take place in various landscapes, the potential impacts to cultural resources addressed in this section are presented as a range of possible impacts.

Table 8.2.11-1: Impact Significance Rating Criteria for Cultural Resources

Type of Effect	Effect Characteristic	Impact Level			
		Adverse Effect	**Mitigated Adverse Effect[a]**	**Effect, but not Adverse**	**No Effect**
Direct effects to historic properties[b]	Magnitude or Intensity	Effects to a contributing portion of a single or many historic properties	*Adverse effect* that has been procedurally mitigated through Section 106 process	Effects to a non-contributing portion of a single or many historic properties	No direct effects to historic properties
	Geographic Extent	Direct effects APE		Direct effects APE	Direct effects APE
	Duration or Frequency	Permanent direct effects to a contributing portion of a single or many historic properties		Permanent direct effects to a non-contributing portion of a single or many historic properties	No direct effects to historic properties
Indirect effects to historic properties (i.e., visual, noise, vibration, atmospheric)	Magnitude or Intensity	Effects to a contributing portion of a single or many historic properties	*Adverse effect* that has been procedurally mitigated through Section 106 process	Effects to a contributing or non-contributing portion of a single or many historic properties	No indirect effects to historic properties
	Geographic Extent	Indirect effects APE		Indirect effects APE	Indirect effects APE
	Duration or Frequency	Long-term or permanent indirect effects to a single or many historic properties		Infrequent, temporary, or short-term, indirect effects to a single or many historic properties	No indirect effects to historic properties
Loss of access to historic properties	Magnitude or Intensity	Effects to a contributing portion of a single or many historic properties	*Adverse effect* that has been procedurally mitigated through Section 106 process	Effects to a non-contributing portion of a single or many historic properties	No segregation or loss of access to historic properties
	Geographic Extent	Any area surrounding historic properties that would cause segregation or loss of access to a single or many historic properties		Any area surrounding historic properties that could cause segregation or loss of access to a single or many historic properties	No segregation or loss of access to historic properties
	Duration or Frequency	Long-term or permanent segregation or loss of access to a single or many historic properties		Infrequent, temporary, or short-term changes in access to a single or many historic properties	No segregation or loss of access to historic properties

APE = Area of Potential Effect

Notes:
[a] Whereas BMPs and mitigation measures for other resources discussed in this Final Programmatic Environmental Impact Statement may be developed to achieve an impact that is *less than significant with BMPs and mitigation measures incorporated* at the programmatic level, historic properties are considered to be "non-renewable resources" given their very nature. As such, any and all unavoidable adverse effects to historic properties, per Section 106 of the National Historic Preservation Act (as codified in *Title 36 of the CFR § 800.6*), would require consultation with the State Historic Preservation Office/Tribal Historic Preservation Office and other consulting parties, including American Indian tribes and Native Hawaiian organizations, to develop appropriate BMPs and mitigation measures.
[b] Per the National Historic Preservation Act, an historic property is defined as any district, archaeological site, building, structure, or object that is either listed or eligible for listing in the National Register of Historic Places (NRHP). Cultural resources present within a project's APE are not historic properties if they do not meet the eligibility requirements for listing in the NRHP. Sites of religious and/or cultural significance refer to areas of concern to Indian tribes and other consulting parties that, in consultation with the respective party or parties, may or may not be eligible for listing in the NRHP. These sites may also be considered traditional cultural property (TCPs). Therefore, by definition, these significance criteria only apply to cultural resources that are historic properties, significant sites of religious and/or cultural significance, or TCPs. For the purposes of brevity, the term "historic property" is used here to refer to either historic properties, significant sites of religious and/or cultural significance, or TCPs.

Specific Regulatory Considerations

As discussed in Section 6.1.11, Cultural Resources, the Proposed Action is considered an undertaking as defined in *36 CFR § 800*, the regulation implementing Section 106 of the National Historic Preservation Act (NHPA). The intent of Section 106, as set forth in its attending regulations, is for federal agencies to take into account the effects of a proposed undertaking on historic properties, which can include traditional cultural properties (TCPs), and to consult with the Advisory Council on Historic Preservation (ACHP); State Historic Preservation Offices (SHPOs); federally recognized American Indian tribes and Native Hawaiian organizations; local governments; applicants for federal assistance, permits, licenses, and other approvals; and any other interested parties with a demonstrated interest in the proposed undertaking and its potential effects on historic properties.

Section 106 establishes a process for the following:

- Identifying historic properties that may be affected by a proposed undertaking;
- Assessing the undertaking's effects on those resources; and
- Engaging in consultation that seeks ways to avoid, minimize, or mitigate adverse effects on properties that are either listed on, or considered eligible for listing on, the National Register of Historic Places (NRHP).

The area in which effects on resources are evaluated is known as the Area of Potential Effect (APE). The APE is defined as

> "… the geographic area or areas within which an undertaking may directly or indirectly cause alterations in the character or use of historic properties, if any such properties exist. The area of potential effects is influenced by the scale and nature of the undertaking and may be different for different kinds of effects caused by the undertaking." (*36 CFR § 800.16(d)*)

The APE would include potential effects areas for both direct and indirect effects. Direct effects physically alter the historic property in some way, and indirect effects are further removed in time or space and diminish some aspect of the historic property, but may not physically alter it. Direct and indirect effects are discussed in further detail below. Although an APE has not been identified for the Proposed Action due to the nature of this programmatic evaluation, site-specific analysis, including identification of a site-specific APE, may be required depending on the site conditions, the type of deployment, or any other permits or permissions necessary to perform individual projects.

To be eligible for listing in the NRHP, a cultural resource must meet at least one of the four criteria for eligibility. The major criteria (*36 CFR § 60.4(a–d)*) used to evaluate the significance of a cultural resource are as follows:

a) It is associated with events that have made a significant contribution to the broad patterns of history;

b) It is associated with the lives of past significant persons;

c) It embodies the distinctive characteristics of a type, period, or method of construction, or that represent the work of a master, or that possess high artistic values, or that represent a significant and distinguishable entity whose components may lack individual distinction; or

d) It has yielded or may be likely to yield information important in history or prehistory.

Properties also need to exhibit integrity of location, materials, setting, design, association, workmanship, and feeling and commonly be at least 50 years old. However, under Criteria Consideration G, a property achieving significance within the past 50 years is eligible if it is of exceptional importance.

As discussed in Section 6.1.11, Cultural Resources, historic properties can also include properties of traditional religious and cultural significance to various populations; these properties are commonly referred to as TCPs. TCP is defined in National Register Bulletin 38 as a place "eligible for inclusion in the NRHP because of its association with cultural practices or beliefs of a living community that (a) are rooted in that community's history, and (b) are important in maintaining the continuing cultural identity of the community" (*NPS 1998*). Because the cultural practices or beliefs that give a TCP its significance are typically still observed in some form at the time the property is evaluated, it is sometimes perceived that the intangible practices or beliefs themselves, not the tangible property, constitute the subject of evaluation. There is naturally a dynamic relationship between tangible and intangible. The beliefs or practices associated with a TCP are of central importance in defining its significance. However, it should be clearly recognized at the outset that the NRHP does not include intangible resources themselves. The entity evaluated must be a tangible property—i.e., a district, site, building, structure, or object. Notably, a property must meet several preconditions in order to meet the federal definition of TCP as articulated in National Register Bulletin 38. These conditions include the ongoing use of a property in spiritual practice or other traditional activities (*NPS 1998*). It is difficult to identify properties of traditional cultural significance because they are often kept secret due to sensitivity around use and location by the effected communities and the National Register discourages nominations of purely natural features "without sound documentation of their historical or cultural significance" (*NPS 1998*). It is through consultation with affected groups themselves that historic properties of religious and cultural significance can be properly identified and evaluated (*ACHP 2008*).

Local, state/territory, tribal, and federal agencies would be consulted as appropriate in findings and determinations made during the Section 106 process, as specified in *36 CFR § 800*. This includes any SHPO/Tribal Historic Preservation Office whose state/territory would physically include any portion of the APE. In addition to the SHPO, the lead federal agencies have an obligation, as appropriate, to work with state/territory and local governments as well as private organizations, applicants, or individuals with a demonstrated interest from initiation to completion of the review under Section 106 of the NHPA. Once the lead federal agency has identified the appropriate SHPO, *36 CFR § 800.3(f)(2)* requires the federal agencies to identify American Indian tribes or Native Hawaiian organizations that may attach religious and cultural significance to historic properties within the APE and invite them to be consulting parties.

In consultation with the SHPO and other effected parties, the criteria of adverse effects to historic properties within the APE to evaluate the potential effect of the Proposed Action on the identified historic properties would be applied, as codified in *36 CFR § 800.5*.

An *adverse effect* is found when an undertaking may alter, directly or indirectly, any of the characteristics of a historic property that qualify the property for inclusion in the NRHP in a manner that would diminish the integrity of the property's location, design, setting, materials, workmanship, feeling, or association, as discussed above. Adverse effects may include reasonably foreseeable indirect effects that occur later in time, are farther removed, or are cumulative.

FirstNet and/or their partners would confer with consulting parties to determine the undertaking's effects on historic properties, to resolve adverse effects, and to develop BMPs and mitigation measures as necessary, practicable, or feasible. As presented in Table 8.2.11-1, effects determinations have the following three possible outcomes:

1. Finding of *no effect* to historic properties – The Proposed Action does not have the potential to cause effects on historic properties that may be present.
2. Finding of *effect, but not adverse* – The historic property would be affected; however, the effects of an undertaking do not meet the criteria of adverse effect, or measures have been taken to avoid or minimize adverse effects.
3. Finding of *adverse effect/mitigated adverse effect* – The undertaking may affect the integrity, which would alter, directly or indirectly, any of the characteristics of a historic property that qualify it for inclusion in the NRHP. If an adverse effect is found, the federal lead agency would consult further to resolve the adverse effect.

Except as described later, if an historic property could be affected, FirstNet and/or their partners would follow the provisions of *36 CFR § 800.5* to determine whether the effects were adverse. If an effect were adverse, FirstNet and/or their partners would consult with the parties identified above to identify practicable and feasible ways to avoid, minimize, or mitigate any potential effects of the Proposed Action pursuant to *36 CFR § 800.6*. Additionally, the ACHP would be notified of the adverse effects and invited to participate in the resolution of adverse effects process. If adverse effects are unavoidable, then the following are potential BMPs and mitigation measures that could be taken to resolve adverse effects:

- Minimization, which would reduce the effects on the resource through partial avoidance, but would not completely eliminate the effects; and
- Mitigation, which would offset that effect through some of the following means:
  - Protection of a similar resource nearby;
  - Detailed documentation of the resource through data recovery (e.g., excavations, in the case of archaeological sites, or Historic American Buildings Survey/Historic American Engineering Record documentation, in the case of historic structures);
  - Contributions to the preservation of cultural heritage in the affected community;

- Interpretative exhibits highlighting information gained about cultural resources through the Proposed Action; or
- Some combination of these strategies.

If adverse effects are unavoidable, FirstNet and/or their partners would be required to develop appropriate BMPs and mitigation measures, as practicable or feasible, in consultation with some combination of the ACHP, SHPO, a Tribal Historic Preservation Office, and other interested parties, and execute a Memorandum of Agreement (MOA) or Programmatic Agreement (PA), depending on the size and length of the individual project or program and the number of parties involved. The MOA or PA would establish a process for ongoing consultation, review, and compliance with federal and territorial historic preservation laws, and describe the actions that would be taken by the parties to meet their cultural resources compliance responsibilities. The MOA or PA would ensure the resolution of adverse effects and that consultation and BMPs and mitigation procedures are followed. The MOA or PA would also include an Unanticipated Discovery Plan, which would detail the procedures taken if unanticipated cultural materials or human remains were encountered during the deployment phase of the Proposed Action. The MOA or PA would be used as a tool to ensure that Section 106 and other applicable state/territory and federal cultural resource laws and regulations, such as the Archaeological Resources Protection Act, Native American Graves Protection and Repatriation Act, American Indian Religious Freedom Act, are complied with and implemented accordingly.

Additionally, FirstNet is permitted under a 2015 Program Comment approved by the ACHP—that renewed and amended an existing 2009 Program Comment—to use its alternative procedures to comply with Section 106 for any potential effects resulting from any proposed construction and modification undertakings that would be subject to review by the Federal Communications Commission under either an existing 2001 or 2004 nationwide PA for telecommunications and collocations. This permits FirstNet to avoid duplicative reviews and complying separately with Section 106 in evaluating any proposed undertaking, when it has already undergone or will undergo, or is exempt from, a review by the Federal Communications Commission under either the 2001 or 2004 PA (*ACHP 2015*).

8.2.11.3. Description of Environmental Concerns

Direct Effects to Historic Properties

The primary cultural resource concern during deployment and operation activities is physical damage to and/or destruction of historic properties. For the purposes of brevity, the term "historic property" is used here to refer to either historic properties as defined by the NHPA, significant sites of religious and/or cultural significance, or traditional cultural properties. Direct effects typically occur to historic properties located within or in close proximity to deployment areas. Impacts caused by deployment or operation are restricted to any historic properties, known or unidentified, within the area of physical disturbance.

Any deployment-related ground disturbing activities, such as grading, excavation, vegetation clearing, or even merely driving equipment off-road has the potential to damage, disturb, or remove known or previously unidentified cultural resources, particularly archaeological sites. Since archaeological sites and the scientific data that can be gathered from them are based on their undisturbed context, the integrity and undisturbed nature of an archaeological site is of utmost importance. Ground-disturbing activities are likely to occur during deployment of Proposed Action facilities and associated infrastructure, both on land and in water, and in the future during operation phase maintenance that could involve unanticipated find events.

An influx of non-local workers into an area could subject known historic properties to an increase in visitors who may not be aware of a resource's local, regional, or national cultural value. Resources could be damaged due to intentional or unintentional looting or vandalism. If previously unidentified cultural resources are identified during deployment or operation, individual project-related personnel collecting artifacts as souvenirs could also impact resources.

Based on the impact significance criteria presented in Table 8.2.11-1, physical damage to and/or destruction of historic properties could be adverse if FirstNet's deployment locations or activities would cause permanent direct effects to a contributing portion of a single or multiple historic properties. As discussed in the affected environment Section 6.1.11, Cultural Resources, known and unidentified cultural resources can occur throughout Puerto Rico. Although parts of the island have been systematically surveyed, cultural resources have been evaluated for their eligibility, and historic properties have been listed on the NRHP, the potential remains for unidentified cultural resources to exist and/or known historic properties to be adversely effected by the Proposed Action. Because prehistoric sites in Puerto Rico are known to occur near coastal areas where populated areas and infrastructure are prevalent, historic properties, such as Pre-Columbian Period archaeological sites, near-shore shipwrecks, and European fortifications would be most susceptible to near-coastal adverse effects. Additionally, prehistoric and historic period archaeological sites and historic structures are commonly located in more level, inland areas where individual project activities could occur. Topographically prominent locations suited for telecommunication infrastructure could also be located near or on sites of religious and/or cultural significance and Pre-Columbian Period sites or within cultural landscapes.

Prior to deployment, site-specific analysis may be required depending on the site conditions, the type of deployment, or any other permits or permissions necessary to perform the work. To the extent practicable, FirstNet does not expect to raze any historic structures or adversely affect any known historic properties as part of siting the Proposed Action. If the proposed deployment activities would have the potential to adversely affect historic properties, FirstNet and/or their partners would apply BMPs and mitigation measures, as practicable or feasible, and consult with appropriate federal, territorial, tribal, and other interested parties to apply appropriate mitigation measures to resolve adverse effects. If after site-specific analysis unanticipated cultural resources were identified during deployment or operation, procedures established within the MOA or PA would be followed to appropriately consult, evaluate, and resolve potential adverse effects to any historic properties. If unmarked human burial remains are encountered, then work in the area of the find must cease immediately and the Puerto Rico SHPO would be contacted before further ground-disturbing activity would occur at the discovery site.

Indirect Effects to Historic Properties

Indirect effects to historic properties could include changes to the views to and from a resource (viewshed impacts); increased noise levels at a resource; vibration; and/or visual or atmospheric effects due to dust, emissions, or pollutants. These types of indirect effects may not only affect a historic property's sense of setting, feeling, or association, but could also indirectly affect the physical characteristics of a historic property.

Indirect effects are typically caused by spatially removed activities due to visual, auditory, vibratory, or atmospheric impacts that occur beyond the physical area of disturbance, but are typically restricted to the immediate area around the emitting source, especially in the case of noise, vibration, dust, or emissions. The size of the area impacted by the indirect effects is determined by a combination of variables including the frequency, duration, intensity, and magnitude of the impacts.

Proposed Action activities that could result in these types of impacts include deployment-related ground disturbance; vegetation clearance; increased noise, vibration, dust, pollutants, and emissions associated with vehicle traffic; and placement of individual project components within viewsheds. The accumulation of dust due to vehicular traffic or deployment activities on historic properties could impact their cultural value to a site user, although they would tend to be minor or limited in extent. The accumulation of other pollutants could have a similar effect as dust and could contribute to physical damage to historic properties from chemical reactions between pollutant and resource materials, although the effects would generally be required to be long-term to cause significant damage.

Historic structures and prehistoric ruins or sensitive features are prone to vibration-related impacts. Vibrations are measured in terms of peak particle velocity. The Swiss Association of Standardization Vibration Damage Criteria states that structures highly sensitive to vibration will sustain damage if continuous vibration activities generate peak particle velocity in the underlying soil of 3.048 millimeters per second (1.2 inches per second) or higher (*Jones & Stokes 2004*). Studies have found that peak particle velocity at or above 2 inches per second will damage historic buildings. Therefore, an industry standard conservative limit for vibration is generally recognized to be 0.5 inches per second, depending on site-specific key factors (*Johnson and Hannen 2015*). The use of heavy equipment during deployment and increased vehicular traffic along established or new access roads during deployment and operation-phase activities could generate localized vibrations sufficient to damage historic properties. The Proposed Action, however, would likely not possess the amount or frequency of vehicular traffic needed to cause significant effects.

Based on the impact significance criteria presented in Table 8.2.11-1, indirect effects to historic properties could be adverse if FirstNet's deployment or operation activities would cause permanent indirect effects to a contributing portion of a single or many historic properties. As discussed in the affected environment Section 8.1.11, Cultural Resources, known and previously unidentified cultural resources can occur throughout Puerto Rico. Although parts of the island have been systematically surveyed, not all areas or cultural resources have been evaluated for their eligibility, and historic properties have been listed on the NRHP, the potential remains for unidentified cultural resources to exist and/or known historic properties to be adversely effected by the Proposed Action. Additionally, in the case of TCPs and cultural resources of religious and/or cultural significance, sites may be difficult to identify, boundaries may not be able to be defined, and the affected cultural groups may not be willing to share information about the sites. Historic properties such as those related to natural features, such as many of the beach sites, cemeteries, or even traditional hunting, fishing, or plant gathering sites, could be adversely affected by effects from views, noise, or emissions. Topographically prominent locations suited for telecommunication infrastructure could also be located within the viewshed of TCPs or other sites of religious and/or cultural significance. Historic properties containing structural components (i.e., La Liendre Bridge) or sensitive or fragile features, such as the Caguana Ceremonial Ball Courts Site, could be susceptible to damage due to vibrations.

As discussed above, site-specific analysis may be required depending on the site conditions, the type of deployment, or any other permits or permissions necessary to perform the work within individual projects. To the extent practicable, FirstNet does not expect to adversely affect any known historic properties as part of siting the Proposed Action. If the proposed deployment activities would have the potential to adversely affect historic properties, FirstNet and/or their partners would apply BMPs and mitigation measures, as practicable or feasible, and consult with appropriate federal, territorial, tribal, and other interested parties to apply appropriate mitigation measures to resolve adverse effects.

Loss of Access to Historic Properties

The goal of historic preservation is not only to preserve and protect historic properties, but also to provide access to cultural resources, especially to those who value them. This is fundamental to all historic properties, primarily to historic properties that are considered TCPs and other sites of religious and/or cultural significance (*NPS 1998*). Effects would be considered adverse if long-term or permanent segregation or loss of access was caused by individual project activities to a single or many historic properties.

Historic resources, especially TCPs, hunting, fishing, or plant gathering sites, graves or cemeteries, and areas of particular religious or traditional importance, can lose their integrity, and thus, their potential eligibility for the NRHP when they become degraded as a result of natural or human disturbance processes. Additionally, loss of integrity can occur when the groups, such as Native Puerto Rican groups, who value these places, can no longer access them, thus losing their ability to use the sites in a traditional way and the cultural connection to the site or place over time.

The cause of the loss of access can be direct or indirect. A historic property such as a cemetery or religious place, such as any of the listed churches, could be physically segregated, excluding public use of the place. However, limitations on access could also be indirect, whereas the use associated with the cultural landscape or traditional gathering area is affected be visual or audible effects long-term or permanently so as practitioners cannot perform traditional uses. Many TCPs are used for practical purposes by those who value them and the resources gathered are vital to continuing cultural and traditional practices.

As discussed above, FirstNet and/or their partners would consult with the appropriate territorial agencies and interested Native Puerto Rican groups to determine the potential effect of the Proposed Action on any identified historic properties. To the extent practicable, FirstNet does not expect to adversely affect access to any known historic properties as part of siting the Proposed Action. If the proposed deployment or operation activities would have the potential to adversely affect historic properties, FirstNet and/or their partners would apply BMPs and mitigation measures, as practicable or feasible, and consult with appropriate federal, territorial, tribal, and other interested parties to apply appropriate mitigation measures to resolve adverse effects.

In addition to the historic properties listed on the NRHP, other known and unknown cultural resources exist across Puerto Rico that have yet to be identified or evaluated for their significance. As indicated by previous surveys and a general understanding of the cultural context, archaeological sites and historic resources are more typically found in certain locations than others given their size, type, and function. Site-specific analysis may be required depending on the site conditions, the type of deployment, or any other permits or permissions necessary to perform the work.

8.2.11.4. Potential Impacts of the Preferred Alternative

The following section assesses potential impacts associated with implementation of the Preferred Alternative, including deployment and operation activities.

Deployment Impacts

As described in Section 2.1.2, Proposed Action Infrastructure, implementation of the Preferred Alternative could result in the deployment of various types of facilities or infrastructure. Depending on the physical nature and location of the facility/infrastructure and the specific deployment requirements, some activities would result in potential impacts to cultural resources and others would not. In addition, and as explained in this section, various type of Preferred Alternative infrastructure could result in a range of effects from *no effects* to *effect, but not adverse* depending on the deployment scenario or site-specific conditions. Site-specific analysis may be required depending on the site conditions, the type of deployment, or any other permits or permissions necessary to perform the work.

Activities Likely to Have No Effects

Of the types of facilities or infrastructure development scenarios described in Section 2.1.2, Proposed Action Infrastructure, the following are likely to have *no effects* to cultural resources under the conditions described below:

- Wired Projects
  - Use of Existing Conduit – New Buried Fiber Optic Plant: Disturbance associated with the installation of fiber optic cable in existing conduit would be limited to entry and exit points of the existing conduit in previously disturbed areas. It is anticipated that there would be no direct or indirect effects to cultural resources because the activities that

would be conducted at these small entry and exit points are within previously disturbed areas and any indirect effect or effects to access would be short-term.

- Use of Existing Buried or Aerial Fiber Optic Plant or Existing Submarine Cable: Lighting up of dark fiber would have *no effects* to cultural resources because there would be no ground disturbance.

- Satellites and Other Technologies
  - Satellite-Enabled Devices and Equipment: The installation of new satellite-compatible infrastructure on existing towers, structures, or buildings (where antennae are already placed) would likely be visible. It is anticipated that the installation of permanent equipment on existing structures and the use of portable devices that use satellite technology would not impact cultural resources because those activities would not require ground disturbance or create new perceptible visual effects. BMPs and mitigation measures (see Chapter 11, BMPs and Mitigation Measures) could help to avoid or minimize potential impacts.
  - Deployment of Satellites: FirstNet does not anticipate launching satellites as part of the deployment of the nationwide public safety broadband network (NPSBN); however, it could include equipment on satellites that are already being launched for other purposes. As adding equipment to an existing launch vehicle is very unlikely to impact cultural resources, it is anticipated that this activity would have *no effect* on cultural resources.

Activities with the Potential to Have Effects

Potential deployment-related impacts to cultural resources as a result of implementation of the Preferred Alternative would encompass a range of effects that could occur as a result of ground disturbance activities, vehicular traffic, the presence of new aboveground structures or components, visual evidence of construction, and the presence of construction equipment. The types of infrastructure development scenarios or deployment activities that could be part of the Preferred Alternative and result in potential effects to cultural resources include the following:

- Wired Projects
  - New Build – Buried Fiber Optic Plant: Plowing (including vibratory plowing), trenching, or directional boring and the construction of points of presence (POPs),[1] huts, or other associated facilities or hand-holes to access fiber could result in potential direct and indirect effects or access effects to cultural resources. Soil disturbance and heavy equipment use associated with plowing, trenching, or directional boring as well as land/vegetation clearing, excavation activities, and landscape grading associated with construction of POPs, huts, or other associated facilities or hand-holes to access fiber could result in direct and indirect effects or access effects to cultural resources. Installation of a new buried fiber optic plant would create visible evidence of construction, including a narrow, impermanent "scar" in the earth where the new fiber

[1] POPs are connections or access points between two different networks, or different components of one network.

optic plant was installed, and the presence of construction equipment used for this installation. BMPs and mitigation measures (see Chapter 11, BMPs and Mitigation Measures) could help to avoid or minimize the potential impacts.

- New Build – Aerial Fiber Optic Plant: Soil excavation and excavated material placement during the installation of new poles could result in potential direct and indirect effects or access effects to cultural resources. The use of heavy equipment during the installation of new poles and hanging of cables could also result in potential direct and indirect effects to cultural resources or access effects to cultural resources. The installation of a new aerial fiber optic plant (i.e., new wires on new cell towers) would have a discernable change on visual conditions. Except if replacing existing infrastructure, this option would add new elements (towers) to a viewshed, and would result in visible evidence of construction activity and equipment. BMPs and mitigation measures (see Chapter 11, BMPs and Mitigation Measures) could help to avoid or minimize potential impacts.
- Collocation on Existing Aerial Fiber Optic Plant: Soil excavation and excavated material placement during the replacement of poles and structural hardening could result in direct and indirect effects to cultural resources, although any effects to access would be short-term. Heavy equipment use associated with these activities as well as with installing new fiber on existing poles could result in direct and indirect effects to cultural resources.
- New Build – Submarine Fiber Optic Plant: The installation of cables in bodies of water could have direct and indirect impacts to submerged cultural resources. Direct and indirect effects as well as access effects to cultural resources could potentially occur as result of the construction of landings and/or facilities on shore to accept submarine cable or the impact of cable placement on submerged resources. Direct and indirect effects to terrestrial cultural resources could potentially occur as result of grading, foundation excavation, or other ground disturbance activities as well as heavy equipment use during these activities. Installation of new associated huts or equipment, however, would create aboveground features and the presence of construction equipment and create visible aboveground components. BMPs and mitigation measures (see Chapter 11, BMPs and Mitigation Measures) could help to avoid or minimize the potential impacts.
- Installation of Optical Transmission or Centralized Transmission Equipment: If installation of transmission equipment would occur in existing boxes or huts and require no ground disturbance (collocations), there would be *no effects* to cultural resources. However, if installation of transmission equipment required grading or other ground disturbance to install small boxes, huts, or access roads, there could potentially be direct and indirect impacts to cultural resources, although access effects would be short-term. Heavy equipment use associated with these activities as well as with installing new fiber on existing poles could result in direct and indirect effects to cultural resources. Installation of new transmission equipment would add a new element to the viewshed, in the form of a small box or hut. BMPs and mitigation measures (see Chapter 11, BMPs and Mitigation Measures) could help to avoid or minimize the potential impacts.

- Wireless Projects
  - New Wireless Communication Towers: Installation of new wireless towers and associated structures (generators, equipment sheds, fencing, security and aviation lighting, electrical feeds, and concrete foundations and pads) or access roads could result in direct and indirect effects or access effects to cultural resources. Land/vegetation clearing, excavation activities, landscape grading, and other ground disturbance activities during the installation of new wireless towers and associated structures or access roads and heavy equipment use could result in direct and indirect effects. Installation of new wireless communication towers would add new elements (towers) to the viewshed and would result in visible evidence of construction activity and equipment. BMPs and mitigation measures (see Chapter 11, BMPs and Mitigation Measures) could help to avoid or minimize potential impacts.
  - Collocation on Existing Wireless Tower, Structure, or Building: Collocation would involve mounting or installing equipment (such as antennas or microwave dishes) on an existing tower. Although the change associated with this option is small, it could cause cumulative visual effects to historic properties within its viewshed. If the onsite delivery of additional power units, structural hardening, and physical security measures required ground disturbance, such as grading or excavation activities, direct and indirect effects to cultural resources could occur, although access effects would be short-term. The use of heavy equipment could also have direct and indirect effects. BMPs and mitigation measures (see Chapter 11, BMPs and Mitigation Measures) could help to avoid or minimize potential impacts.
- Deployable Technologies
  - Implementation of deployable technologies could result in potential direct and indirect effects to cultural resources if deployment of land-based deployables occurs in unpaved areas, or if the implementation results in minor construction or paving of previously unpaved surfaces. Some staging or landing areas (depending on the type of technology) could require land/vegetation clearing, minor excavation, and paving. These activities could result in direct and indirect effect to cultural resources, although access effects would be unlikely. Heavy equipment use associated with these activities and implementation of deployable technologies themselves could result in direct and indirect effects if deployed in unpaved areas. It is anticipated that there would be *no effects* to access or the viewshed during deployment of the deployable technologies.

In general, the abovementioned activities could potentially involve land/vegetation clearing, excavation, excavated material placement, trenching or directional boring, construction of access roads and other impervious surfaces, landscape grading, heavy equipment movement, and installation of aboveground components. Potential effects to cultural resources associated with deployment of this infrastructure could include direct and indirect effects or access effects to cultural resources. Site-specific analysis may be required depending on the site conditions, the type of deployment, or any other permits or permissions necessary to perform the work. These effects and associated BMPs and mitigation measures that could help to mitigate or reduce these impacts are described further below.

Direct Effects to Historic Properties

Based on the analysis of the deployment activities described above to cultural resources, the impact rating as a result of direct effects is anticipated to be *effect, but not adverse*. See Chapter 11, BMPs and Mitigation Measures, for a listing of BMPs and mitigation measures that FirstNet and/or their partners would require, as practicable or feasible, to help avoid or minimize the potential impacts to these resources.

FirstNet is committed to avoidance of direct effects to historic properties to the maximum extent practicable. The key time to implement avoidance actions is during siting and deployment, prior to and during Preferred Alternative activities. Therefore, site-specific analysis may be required depending on the site conditions, the type of deployment, or any other permits or permissions necessary to perform the work.

Further, the establishment of an unanticipated discovery plan during deployment and operation would be implemented to ensure that procedures are followed if unanticipated cultural materials or human remains were encountered during the deployment and operation of the Preferred Alternative, and that BMPs and mitigation measures are fully and effectively implemented and unanticipated effects to historic properties are not occurring. For activities that could adversely affect historic properties, FirstNet and/or their partners would develop appropriate BMPs and mitigation measures, as practicable or feasible, in consultation with some combination of the ACHP, SHPO, a Tribal Historic Preservation Office, and other interested parties to execute a MOA or PA, depending on the size and length of the individual project or program and the number of parties involved. The MOA or PA would establish a process for ongoing consultation, review, and compliance with federal and territorial historic preservation laws, and describe the actions that would be taken by the parties in order to meet their cultural resources compliance responsibilities. The MOA or PA would ensure the resolution of adverse effects and that consultation and mitigation procedures are followed. The MOA or PA would be used as a tool to ensure that Section 106 and other applicable territorial and federal cultural resource laws and regulations, such as the Archaeological Resources Protection Act, Native American Graves Protection and Repatriation Act, American Indian Religious Freedom Act, and territorial laws, are complied with and implemented accordingly.

Potential Indirect Effects to Historic Properties

Based on the analysis of the deployment activities described above to cultural resources, the impact rating as a result of indirect effects is anticipated to be *effect, but not adverse*.
See Chapter 11, BMPs and Mitigation Measures, for a listing of BMPs and mitigation measures that FirstNet and/or their partners would require, as practicable or feasible, to help avoid or minimize the potential impacts to these resources.

Potential Loss of Access to Historic Properties

Based on the analysis of the deployment activities described above to cultural resources, the impact rating as a result of direct and indirect effects to access is anticipated to be *effect, but not adverse*. See Chapter 11, BMPs and Mitigation Measures, for a listing of BMPs and mitigation measures that FirstNet and/or their partners would require, as practicable or feasible, to help avoid or minimize the potential impacts to these resources.

Operation Impacts

As described in Section 2.1.2, Proposed Action Infrastructure, operation activities associated with the Preferred Alternative would consist of routine maintenance and inspection of the facilities. Any major infrastructure replacement as part of ongoing system maintenance would result in impacts similar to the abovementioned deployment impacts. It is anticipated that there would be *no effects* to historic properties associated with routine inspections of the Preferred Alternative, assuming that the same access roads used for deployment are also used for inspections and the activities are infrequent and temporary. If usage of heavy equipment as part of routine maintenance or inspections occurs off of established access roads or corridors, direct and indirect effects or temporary access effects could result as explained above.

8.2.11.5. Alternatives Impact Assessment

The following section assesses potential impacts to historic properties associated with the Deployable Technologies Alternative and the No Action Alternative.[2]

Deployable Technologies Alternative

Under the Deployable Technologies Alternative option, a nationwide fleet of land-based and aerial mobile communications systems would provide temporary coverage in areas not covered by the existing, usable infrastructure. There would be no collocation of equipment and no new construction associated with wired or wireless projects discussed above under the Preferred Alternative. Some limited construction could be associated with implementation such as land clearing or paving for parking or staging areas. The specific infrastructure associated with the Deployable Technologies Alternative would be the same as the deployable technologies implemented as part of the Preferred Alternative but would likely be implemented in greater numbers, over a larger geographic extent, and used with greater frequency and duration. Potential effects to historic properties as a result of implementation of this alternative are described below.

Deployment Impacts

As explained above, implementation of land-based deployable technologies could result in *effects, but not adverse* to historic properties if deployment of land-based deployables occurs in unpaved areas or if the implementation results in paving of previously unpaved surfaces. Some staging or landing areas (depending on the type of technology) could require land/vegetation

[2] As mentioned above and in Section 2.1.2, Proposed Action Infrastructure, the Preferred Alternative includes implementation of deployable technologies.

clearing, excavation, and paving. These activities could result in direct and indirect effect to cultural resources, although access effects would be unlikely. Heavy equipment use associated with these activities and implementation of deployable technologies themselves could result in direct and indirect effects if deployed in unpaved areas. It is anticipated that there would be *no effects* to access or the viewshed during deployment of the deployable technologies.

Operation Impacts

As explained above, operation activities would consist of implementation/running of the deployable technology and routine maintenance and inspections. As with the deployment impacts, it is anticipated that there would be *effects, but not adverse* to historic properties associated with implementation/running of the deployable technology because effects to access or the viewshed could occur, depending on the length of deployment. Assuming that the same access roads used for deployment are also used for inspections, it is anticipated that there would be *no effects* to historic properties due to inspections. If usage of heavy equipment as part of routine maintenance or inspections occurs off of established access roads or corridors, *effects, but not adverse* to historic properties could result as previously explained above.

No Action Alternative

Under the No Action Alternative, the NPSBN would not be deployed; therefore there would be no associated deployment or operation of wired, wireless, deployable infrastructure or satellites and other technologies. As a result, there would be *no effects* to historic properties because there would be no deployment or operation of the Proposed Action. Environmental conditions would therefore be the same as those described in Section 8.1.11, Cultural Resources.

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8.2.12. Air Quality

8.2.12.1. Introduction

This section describes potential impacts to air quality in Puerto Rico associated with deployment and operation of the Proposed Action. Mitigation measures, as defined through permitting and/or consultation with the appropriate resource agency, would be implemented as part of deployment and operation of the Proposed Action to help avoid or reduce potential impacts to air quality. Implementation of best management practices (BMPs), as practicable or feasible, could further reduce the potential for impacts. Both mitigation measures and BMPs are discussed in Chapter 11, BMPs and Mitigation Measures.

8.2.12.2. Impact Assessment Methodology and Significance Criteria

The potential impacts of the Proposed Action on air quality were evaluated using the significance criteria presented in Table 8.2.12-1. As described in Section 8.2, Environmental Consequences, the categories of impacts are defined at the programmatic level as *potentially significant*, *less than significant with BMPs and mitigation measures incorporated*, *less than significant*, or *no impact*. Characteristics of the potential air quality impact, including magnitude or intensity, geographic extent, and duration or frequency, were used to determine the impact significance rating associated with each potential impact.

Given the nature of this programmatic evaluation, and because the Proposed Action could potentially cover a wide variety of actions that would take place in various landscapes, the potential impacts to air quality addressed in this section are presented as a range of possible impacts.

Table 8.2.12-1: Impact Significance Rating Criteria for Air Quality

Type of Effect	Effect Characteristic	Impact Level			
		Potentially Significant	**Less than Significant with BMPs and Mitigation Measures Incorporated**	**Less than Significant**	**No Impact**
Increased air emissions	Magnitude or Intensity	Emissions would prevent progress toward meeting one or more NAAQS in nonattainment areas. Emissions in attainment or maintenance areas would cause an exceedance for any NAAQS. Emissions exceed one or more major source permitting thresholds. Projects do not conform to SIP.	Effect that is *potentially significant*, but with mitigation is *less than significant* at the programmatic level	Negligible emissions would occur for any pollutant within an attainment area, but would not cause a NAAQS exceedance and would not trigger major source permitting	Emission increases would be infrequent or absent, mostly immeasurable; projects conform to SIP
	Geographic Extent	NA		NA	NA
	Duration or Frequency	Permanent or long-term		Short-term	Temporary

NA = not applicable; NAAQS = National Ambient Air Quality Standards; SIP = State (or Territory) Implementation Plan

8.2.12.3. Description of Environmental Concerns

Increased air emissions could result in potentially adverse impacts to human health, wildlife, vegetation, and visibility. Emissions could result from stationary or mobile equipment that is powered by fossil fuels such as excavators, backhoes, frontend loaders, graders, pavers, dump trucks, etc. required to support any clearance, drilling, and construction activities associated with network deployment. In addition, the use of power generators, first responder on-road vehicles (large towable trailers, commercial trucks, standard sport utility vehicles), and aerial platforms (unmanned aircraft such as drones and piloted aircraft such as airplanes and blimps) associated with the implementation of deployable technologies could also increase air emissions, both from fossil fuel combustion and, in some cases, from stirring up dust on unpaved roads. Helicopters, if needed, would likely only be used during deployment of one of the above technologies to potentially move people or equipment to remote areas. The use of helicopters would be infrequent, if at all; therefore, potential impacts associated with the use of helicopters are not evaluated here.

Potential impacts from increased air emissions could occur in any location; however, the most affected areas are nonattainment areas (where air quality is not meeting local standards), maintenance areas (where air quality has improved but historically did not meet local standards), and designated Class I Areas (areas of special national or cultural significance including certain national parks, wilderness areas, and national monuments). Nonattainment and maintenance areas are sensitive to increased air pollution because of their existing air quality concerns; Class I Areas are sensitive because of the expectation for pristine air quality and visibility in these areas (see Section 8.1.12, Air Quality).

There are no Class I Areas in Puerto Rico. However, because Puerto Rico contains nonattainment and maintenance areas (Arecibo, Guaynabo County), and infrastructure could be built in, or deployed to, these areas, BMPs and mitigation measures (see Chapter 11, BMPs and Mitigation Measures) could help avoid or minimize potential air quality impacts. In addition, it is anticipated that any air pollution increase due to deployment would likely be short-term with pre-existing air quality levels generally achieved after some months (typically less than a year, and could be as short as a few hours or days for some activities such as pole construction).

8.2.12.4. Potential Impacts of the Preferred Alternative

The following section assesses potential impacts associated with implementation of the Preferred Alternative, including deployment and operation activities. Estimated emissions associated with the Preferred Alternative are compared to the permitting thresholds for new major stationary sources in order to evaluate the significance of potential air quality impacts. Because the air emissions associated with most of the construction/deployment activities (excluding use of mobile power generators for deployment technologies if on-site for 12 consecutive months or more) are solely from mobile construction equipment/vehicles, these non-stationary sources or activities would not be subject to territory air quality requirements that would require consultation or permitting actions. Emissions from the non-stationary sources (and sources not covered by a New Source Review permit) are subject to the general conformity requirements, if such emissions are generated in areas designated as nonattainment or maintenance for any criteria pollutant or its pre-cursor. The major stationary source permitting thresholds are lower for modifications (rather than new sources); however, these thresholds are based on an increase in emissions compared to the existing source. It is anticipated that any modifications associated with the Preferred Alternative (e.g., replacement of an existing diesel generator) would involve equipment of the same size with emissions performance equal to or better than the existing equipment. Therefore, only new emission sources are quantitatively evaluated to determine significance.

As noted in Section 8.1.12, Air Quality, one area of Puerto Rico, Arecibo, is designated as a nonattainment area for lead, so the applicable threshold is 100 tons per year (tpy) for lead and 250 tpy for each of the other criteria pollutants emitted by a stationary source. Lead emissions were not quantified in the following assessment because all fuels are anticipated to be unleaded and no measurable amount of lead emissions are expected as a result of the Preferred Alternative. Additionally, one area of Puerto Rico (Guaynabo County) is designated as a maintenance area for particulate matter with a diameter of 10 micrometers or less (PM_{10}). Although the major source permitting threshold for PM_{10} is still 250 tpy, the threshold for triggering general conformity requirements for PM_{10} is 100 tpy (see Section 8.1.12.3, Ambient Air Quality). Therefore, PM_{10} emissions estimates below are evaluated relative to the 100-tpy threshold.

Furthermore, within the United States and its territories, there are no air quality permitting programs, and thus no thresholds, for mobile sources such as construction equipment/activities, motor vehicles, small boats, airplanes, and drones.[1] As noted in Section 8.1.12, Air Quality, emissions from each of these mobile emission sources are regulated through fuel standards and inspection/maintenance programs. The proposed BMPs and mitigation measures (see Chapter 11, BMPs and Mitigation Measure) could help avoid or minimize potential air quality impacts associated with these mobile emission sources. Nonetheless, to provide additional context, emissions from construction equipment/activities and motor vehicles are estimated below and compared to the 250- and 100-tpy major source permitting and general conformity thresholds, although these thresholds would not apply to such emissions for permitting purposes.

Finally, the following analyses consider pollutant emission rates only. Changes to ambient air pollutant concentrations through air dispersion modeling (which accounts for emission rates, source parameters, meteorological conditions, building wake effects, and terrain effects) and associated potential impacts relative to local ambient air quality standards, are not evaluated. More detailed Preferred Alternative information would be needed to model potential air emission impacts relative to local ambient air quality standards.

[1] The Clean Air Act (CAA), as amended through the 1990 Clean Air Act Amendments, defines "stationary source" in *Title III, General Provisions*, Section 302, Definitions, paragraph (z) [*CAA § 302(z)*] such that any source of air emissions resulting directly from a non-road engine is not regulated as a stationary source under the CAA and are therefore exempt from federal stationary source permitting requirements. The definition of a non-road engine in *Title II, Emission Standards for Moving Sources*, Section 216, Definitions of the CAA is codified in *40 CFR § 89.2* and *40 CFR § 90.3*. As defined in these parts, internal combustion engines that are mobile (i.e., portable or transportable) engines are considered non-road engines. Therefore, internal combustion engines such as portable generators, air compressors, welders, etc. that do not stay at any single site at a building, structure, facility, or installation for 12 consecutive months or more, are considered non-road engines.

Potential Deployment Impacts

As described in Section 2.1.2, Proposed Action Infrastructure, implementation of the Preferred Alternative could result in the deployment of various types of facilities or infrastructure. Depending on the physical nature and location of the facility/infrastructure and the specific deployment requirements, some activities would result in potential impacts to air quality and others would not. In addition, and as explained in this section, various types of Preferred Alternative infrastructure could result in a range of *no impacts* to *less than significant* impacts at the programmatic level depending on the deployment scenario or site-specific conditions. Site-specific analysis may be required depending on the site conditions, the type of deployment, or any other permits or permissions necessary to perform the work.

Activities Likely to Have No Impacts

Of the types of facilities or infrastructure development scenarios described in Section 2.1.2, Proposed Action Infrastructure, the following are likely to have *no impacts* to air quality at the programmatic level under the conditions described below:

- Wired Projects:
  - Use of Existing Conduit-New Buried Fiber Optic Plant: Although existing conduits would be used, these projects could involve construction equipment for cable pulling, blowing. However due to the temporary and intermittent need for such machinery, there would be no perceptible increase in air emissions.
  - Use of Existing Buried or Aerial Fiber Optic Plant or Existing Submarine Cable: Lighting up dark fiber would have *no impacts* to air quality because it would not create any sources of air emissions. It is expected that no heavy equipment would be used and that transportation activities would be temporary, producing a negligible quantity of air pollution.
- Satellites and Other Technologies:
  - Deployment of Satellites: FirstNet does not anticipate launching satellites as part of the deployment of the nationwide public safety broadband network (NPSBN); however, it could include equipment on satellites that are already being launched for other purposes. As adding equipment to an existing launch vehicle would be very unlikely to impact air quality resources, it is anticipated that this activity would have *no impact*.

Activities with the Potential to Have Impacts

Potential deployment-related impacts to air quality as a result of implementation of the Preferred Alternative would encompass a range of potential impacts that could occur as a result of fossil fuel combustion associated with on-road and off-road engines, and as a result of motor vehicles or heavy equipment stirring up dust on unpaved roads. The types of infrastructure development scenarios or deployment activities that could be part of the Preferred Alternative and result in potential impacts to air quality include the following activities.

Wired Projects

For buried wired projects, construction activities could include plowing (including vibratory plowing), trenching, or directional boring, depending on the nature of the terrain, geology, and environmental conditions. These activities could result in potential impacts to air quality as a result of associated fuel-burning equipment (combustion emissions) and ground disturbance (fugitive dust). This section excludes air emissions associated with trenching and horizontal boring activities as these are expected to be lower or similar to plowing activities (i.e., only one of the three options would likely occur at a particular location depending on the nature of the terrain, geology, and environmental conditions). For aerial wired projects, construction activities could include new wiring and poles that require use of auger trucks, boom trucks, and bucket lifts, as well as excavation and grading for new or modified rights-of-way or easements.

Additional activities associated with installation of new, or modifications to existing, wired systems (buried and aerial) and the construction of points of presence,[2] huts, or other associated facilities could result in air emissions from cable blowing, pulling, and vault placement. In other cases, new structures could be required without the need for new or modified wired systems. The deployment of marine vessels to lay submarine cable is unlikely; however, small work boats (with engines similar to recreational vehicle engines) may be required to transport and lay small wired cable in limited near-shore or inland bodies of water, but emissions from these small marine sources are expected to be negligible and were not quantified. Associated combustion emissions estimates for the anticipated fuel-burning equipment are presented in Table 8.2.12-2 through Table 8.2.12-4.

Furthermore, deployment of wired projects could potentially impact air quality as a result of associated excavation/filling and grading/earth moving activities. Associated fugitive dust emissions estimates are presented in Table 8.2.12-5.

Wired project deployment would also involve other on-road vehicle use, including employee transportation to and from work sites. However, these ancillary activities would be temporary and would produce a negligible quantity of air pollution. Therefore, emissions associated with these ancillary activities were not quantified.

[2] Points of presence are connections or access points between two different networks, or different components of one network.

Table 8.2.12-2: Combustion Emission Estimates (Monthly) from New Buried Wired Project Deployment[a]

Emission Source[b,c]	Estimated Emissions (tons/month)[d,e,f]					
	NOx	CO	VOC	PM_{10}	$PM_{2.5}$	SO_2
Vibratory Plow	0.329	0.110	0.015	0.002	0.001	0.0004
Backhoe	0.328	0.108	0.015	0.001	0.001	0.0004
Dozer	0.330	0.114	0.015	0.002	0.002	0.0004
Flat-bed Truck	0.333	0.124	0.016	0.002	0.002	0.0004
Pick-up Truck	0.333	0.124	0.016	0.002	0.002	0.0004
Trench Roller	0.330	0.112	0.015	0.002	0.002	0.0004
Air Compressor	0.329	0.110	0.015	0.002	0.001	0.0004
Cable Puller/Blower	0.327	0.103	0.015	0.001	0.001	0.0004
Concrete Mixer	0.328	0.105	0.015	0.001	0.001	0.0004
Grader	0.330	0.115	0.015	0.002	0.002	0.0004
Roller	0.330	0.112	0.015	0.002	0.002	0.0004
Total	**3.630**	**1.240**	**0.166**	**0.018**	**0.017**	**0.004**

CO = carbon monoxide; NOx = nitrogen oxides; $PM_{2.5}$ = particulate matter up to 2.5 micrometers in diameter; PM_{10} = particulate matter up to 10 micrometers in diameter; SO_2 = sulfur dioxide; VOC = volatile organic compound

[a] Deployment activities are assumed to include plowing, wire installation, and construction of points of presence and fiber huts.

[b] Emissions are based on one unit of typical equipment. If additional equipment is required, equipment-specific emission estimates should be multiplied by the number of equipment units.

[c] Each equipment is assumed to have a maximum rated capacity of 300 horsepower and to be 10 years old (equipment age). If new equipment is used, emissions would be lower.

[d] Emissions are estimated using methodology from *Exhaust and Crankcase Emission Factors for Nonroad Engine Modeling - Compression-Ignition*, Equations 1 to 7, NR-009d, July 2010 (*USEPA 2010a*). Typical equation values were obtained from *Median Life, Annual Activity, and Load Factor Values for Nonroad Engine Emissions Modeling*, EPA-420-R-10-016, NR-005d, July 2010 (*USEPA 2010b*).

[e] Emissions (tons) per month assume 240 hours (24 days, 10 hours/day) of construction activity per month. If construction lasts for 4 months, estimated air pollutant emissions would be expected to be four times as large as the values listed here.

[f] Fuel is assumed to be ultra-low sulfur diesel with a maximum sulfur content of 15 parts per million.

Table 8.2.12-3: Combustion Emission Estimates (Monthly) from New Aerial Wired Project Deployment[a]

Emission Source[b,c]	Estimated Emissions (tons/month)[d,e,f]					
	NOx	CO	VOC	PM_{10}	$PM_{2.5}$	SO_2
Grader	0.330	0.115	0.015	0.002	0.002	0.0004
Suction Excavator	0.331	0.117	0.015	0.002	0.002	0.0004
Auger Truck	0.328	0.107	0.015	0.001	0.001	0.0004
Boom Truck	0.330	0.112	0.015	0.002	0.002	0.0004
Cable Puller/ Blower	0.327	0.103	0.015	0.001	0.001	0.0004
Bucket Lift	0.327	0.104	0.015	0.001	0.001	0.0004
Flat-bed Truck	0.333	0.124	0.016	0.002	0.002	0.0004
Total	**2.310**	**0.781**	**0.106**	**0.011**	**0.011**	**0.0030**

CO = carbon monoxide; NOx = nitrogen oxides; $PM_{2.5}$ = particulate matter up to 2.5 micrometers in diameter; PM_{10} = particulate matter up to 10 micrometers in diameter; SO_2 = sulfur dioxide; VOC = volatile organic compound

[a] Deployment activities are assumed to include excavation, grading, and pole delivery and installation.

[b] Emissions are based on one unit of typical equipment. If additional equipment is required, equipment-specific emission estimates should be multiplied by the number of equipment units.

[c] Each equipment is assumed to have a maximum rated capacity of 300 horsepower and to be 10 years old (equipment age). If new equipment is used, emissions would be lower.

[d] Emissions are estimated using methodology from *Exhaust and Crankcase Emission Factors for Nonroad Engine Modeling - Compression-Ignition*, Equations 1 to 7, NR-009d, July 2010 (*USEPA 2010a*). Typical equation values were obtained from *Median Life, Annual Activity, and Load Factor Values for Nonroad Engine Emissions Modeling*, EPA-420-R-10-016, NR-005d, July 2010 (*USEPA 2010b*).

[e] Emissions (tons) per month assume 240 hours (24 days, 10 hours/day) of construction activity per month. If construction lasts for 4 months, estimated air pollutant emissions would be expected to be four times as large as the values listed here.

[f] Fuel is assumed to be ultra-low sulfur diesel with a maximum sulfur content of 15 parts per million.

Table 8.2.12-4: Combustion Emission Estimates (Monthly) from Tower, Structure, and Transmission Equipment Delivery and Installation

Emission Source[a,b]	Estimated Emissions (tons/month)[c,d,e]					
	NOx	CO	VOC	PM_{10}	$PM_{2.5}$	SO_2
Concrete Mixer	0.328	0.105	0.015	0.001	0.001	0.0004
Flat-bed Truck	0.333	0.124	0.016	0.002	0.002	0.0004
Grader	0.330	0.115	0.015	0.002	0.002	0.0004
Paver	0.330	0.113	0.015	0.002	0.002	0.0004
Roller	0.330	0.112	0.015	0.002	0.002	0.0004
Truck-mounted Crane	0.330	0.112	0.015	0.002	0.002	0.0004
Total	**1.980**	**0.681**	**0.091**	**0.010**	**0.010**	**0.002**

CO = carbon monoxide; NOx = nitrogen oxides; $PM_{2.5}$ = particulate matter up to 2.5 micrometers in diameter; PM_{10} = particulate matter up to 10 micrometers in diameter; SO_2 = sulfur dioxide; VOC = volatile organic compound

[a] Emissions are based on one unit of typical equipment. If additional equipment is required, equipment-specific emission estimates should be multiplied by the number of equipment units.

[b] Each equipment is assumed to have a maximum rated capacity of 300 horsepower and to be 10 years old (equipment age). If new equipment is used, emissions would be lower.

[c] Emissions are estimated using methodology from *Exhaust and Crankcase Emission Factors for Nonroad Engine Modeling - Compression-Ignition*, Equations 1 to 7, NR-009d, July 2010 (*USEPA 2010a*). Typical equation values were obtained from *Median Life, Annual Activity, and Load Factor Values for Nonroad Engine Emissions Modeling*, EPA-420-R-10-016, NR-005d, July 2010 (*USEPA 2010b*).

[d] Emissions (tons) per month assume 240 hours (24 days, 10 hours/day) of construction activity per month. If construction lasts for 4 months, estimated air pollutant emissions would be expected to be four times as large as the values listed here.

[e] Fuel is assumed to be ultra-low sulfur diesel with a maximum sulfur content of 15 parts per million.

Table 8.2.12-5: Dust Emission Estimates (Monthly) from Excavation/Filling and Grading/Earth Moving Activities

Emission Source	Estimated Level of Activity	Estimated Emissions (tons/month)[a,b,c]		
		PM	PM_{10}	$PM_{2.5}$
Excavation and Filling	100,000 tons of material transferred [d]	0.240	0.114	0.017
Grading and Earth Moving	1,200 vehicle miles traveled per month [e]	1.340	0.459	0.042
Total		**1.580**	**0.573**	**0.059**

PM = particulate matter; $PM_{2.5}$ = particulate matter up to 2.5 micrometers in diameter PM_{10} = particulate matter up to 10 micrometers in diameter;

[a] Emissions are estimated using methodology from *AP-42*, *Compilation of Air Pollutant Emission Factors* (*USEPA 1998* and *USEPA 2006)*.

[b] Excavation and filling emissions are based on *Section 13.2.4, Aggregate Handling and Storage Piles* - Equation (1) (*USEPA 2006*). Mean wind speed is assumed to be 8.3 meters per second (18.6 miles per hour) based on National Oceanic and Atmospheric Administration data for Puerto Rico (refer to Section 8.1.14, Climate Change). Moisture content is assumed to be the median value (2.525%) listed in AP-42. Control efficiency is assumed to be zero (worst-case scenario).

[c] Grading and earth moving emissions are based on *Section 11.9, Western Surface Coal Mining* - Table 11.9-1 (*USEPA 1998*). Mean speed for construction vehicles is assumed to be 5 miles per hour. Emissions (tons) per month assume 240 hours (24 days, 10 hours/day) of construction activity per month. Emission estimates could be scaled proportionally based on the number of months required for grading and earth moving activities.

[d] Excavation and filling emissions assume 100,000 tons of material transferred per month. Emissions estimates could be scaled proportionally based on actual monthly estimates for material transfer (e.g., if monthly material transfer is to be 200,000 tons, associated PM emissions would be 0.480 tons).

[e] Vehicle miles traveled is based on average speed (5 miles per hour) and operating time per month (240 hours) (see note c above). Emission estimates cannot be directly scaled based on an increase/decrease in vehicle miles traveled – refer to equations in *AP-42*, Table 11.9-1(*USEPA 1998*).

Potential air quality impacts associated with each type of wired project are discussed below:

- New Build–Buried Fiber Optic Plant: These projects could involve plowing (including vibratory plowing), trenching, or directional boring (depending on the nature of the terrain, geology, and environmental conditions), as well as the construction of points of presence, huts, or other associated facilities or hand-holes to access fiber. The associated fuel-burning emissions are estimated in Table 8.2.12-2; the associated dust emissions are estimated in Table 8.2.12-5. For example, monthly nitrogen dioxides (NOx) emissions are the highest of all criteria pollutant emissions, at approximately 3.6 tons (based on the assumptions noted with each table); annual NOx emissions, if construction lasted for at least 1 year, would be approximately 44 tons. The annual estimate for each criteria pollutant is less than the major source permitting threshold of 250 tons. Additionally, emissions of PM_{10} would be expected to be approximately 7.1 tpy, less than the 100-tpy general conformity threshold. Even if additional equipment, beyond the equipment assumed in these calculations, was needed, it is still unlikely that emissions would reach the major source or general conformity thresholds.
- New Build–Aerial Fiber Optic Plant: These projects would not require plowing, trenching, or directional boring. However, they could require construction of new wiring and poles, as well as excavation and grading for new or modified right-of-ways or easements. The associated fuel-burning emissions are estimated in Table 8.2.12-3; the associated dust emissions are estimated in Table 8.2.12-5. These emissions are smaller in magnitude than the total emissions associated with New Build–Buried Fiber Optic Plant projects. Even if

additional equipment, beyond the equipment assumed in these calculations, was needed, it is still unlikely that emissions would reach the major source or general conformity thresholds.

- Collocation on Existing Aerial Fiber Optic Plant: These projects could require replacement of existing wiring and poles. These emissions are expected to be smaller in magnitude than the total emissions associated with New Build–Aerial Fiber Optic Plant projects.
- New Build–Submarine Fiber Optic Plant: The deployment of large marine vessels to lay submarine cable is unlikely; however, small work boats (with engines similar to recreational vehicle engines) may be required to transport and lay small wired cables in limited near-shore or inland bodies of water, but emissions from these small marine sources would be negligible.
- Installation of Optical Transmission or Centralized Transmission Equipment: These projects could involve installation of boxes, huts, or other structures. Equipment delivery could require large trucks/trailers and installation could require cranes or skylifts. These projects could also require excavation and grading for new equipment and/or access roads. Therefore, emissions could include the sum of the emission estimates in Tables 8.2.12-4 and 8.2.12-5. Assuming at least 1 year of activity, these emissions are also below the 250- and 100-tpy thresholds.

Wireless Projects

Wireless projects would involve similar, but fewer, air emission sources than the previously discussed wired projects. Emissions associated with installation of towers and other structures are comparable to the estimates in Table 8.2.12-4. Potential air quality impacts associated with each type of wireless project are discussed below:

- New Wireless Communication Towers: These projects could involve installation of new wireless towers and associated structures (backup power generators and equipment sheds, fencing, security and aviation lighting, electrical feeds, and concrete foundations and pads). Installation emissions are expected to correspond to those listed in Table 8.2.12-4 (emissions associated with backup power generators are discussed in the Potential Operation Impacts section below). For example, monthly NOx emissions are the highest of all criteria pollutant emissions, at approximately 1.98 tons (based on the assumptions noted in Table 8.2.12-4); total NOx emissions for one tower, if construction lasted for a maximum of four months, would be approximately 8 tons. The annual estimate for each criteria pollutant is less than the major source permitting threshold of 250 tons. Additionally, emissions of PM_{10} would be expected to be approximately 0.04 ton, which is less than the 100-tpy general conformity threshold. Based on the assumptions stated in Table 8.2.12-4, at least 32 such simultaneous tower installations would be needed for any criteria pollutant to trigger the major source permitting threshold of 250 tons. Similarly, at least 2,500 such simultaneous tower installations would be needed for PM_{10} to trigger the general conformity threshold of 100 tpy.

- Collocation on Existing Wireless Tower, Structure, or Building: Collocation would involve mounting or installing equipment (such as antennas or microwave dishes) on an existing tower. Delivery and installation of equipment could require trucks and cranes that would generate air emissions. Additionally, these projects could require some work on structure foundations and thus concrete mixing equipment. Because these projects would not involve installation of new wireless towers and associated structures, air emissions are expected to be smaller in magnitude than the total emissions associated with New Wireless Communication Towers projects.

Deployable Technologies

Deployable technologies could potentially impact air quality because of their use of fuel-burning equipment, including first responder on-road vehicles, mobile power generators (diesel power generators are assumed as most likely fossil fuel technology; although gasoline-fueled and hydrogen-fueled generators could be an option), and aerial vehicles such as drones, airplanes, and blimps. In addition, some limited construction could be associated with the implementation of deployable technologies such as land clearing or paving for parking or staging areas.

During deployment, on-road vehicles could include light-duty trucks for Cell on Light Truck projects or heavy-duty trucks for Cell on Wheels and System on Wheels projects. Vehicle emissions are estimated in Tables 8.2.12-6 and 8.2.12-7; diesel generator emissions are discussed in the Potential Operation Impacts section. This deployment phase is expected to occur over a few days. Potential air quality impacts of the long-term implementation of the deployment technologies at deployment locations (some months to a year or more) are discussed in the Potential Operation Impacts section. Potential air quality impacts associated with each type of deployable technology project are discussed below.

Table 8.2.12-6: Combustion Emission Estimates from Heavy-Duty Vehicles

Pollutant	Emission Factor[a,b]	Estimated Emissions[c]	
	g/hp-hr	lb/day	tons/year
NOx [b]	2.28	22.10	0.022
CO	15.50	150.00	0.150
$PM/PM_{10}/PM_{2.5}$	0.10	0.97	0.001
VOC [b]	0.12	1.16	0.001

CO = carbon monoxide; g/hp-hr = grams per horsepower-hour; lb/day = pounds per day; NOx = nitrogen oxides; PM = particulate matter; $PM_{2.5}$ = particulate matter up to 2.5 micrometers in diameter; PM_{10} = particulate matter up to 10 micrometers in diameter; VOC = volatile organic compound

[a] Emission factors taken from *40 Code of Federal Regulations 86.004-11(a)(1)* (*Emission Standards for 2004 and Later Model Year Diesel Heavy-Duty Engines and Vehicle)*. Emission factors for PM, PM_{10}, and $PM_{2.5}$ were assumed to be the same. SO_2 emission factors were not provided for heavy-duty trucks but these are expected to be negligible due to the likely use of fuels with low sulfur content.

[b] NMHC/NOx (non-methane hydrocarbon compounds/nitrogen oxides) emission factor was split 5%/95% for VOC (assumed equal to NMHC) and NOx, respectively (based on California guidance [*CARB 2008*]).

[c] Emissions are estimated assuming one vehicle operates 8 hours per day, 2 days per year (one day for driving to location, one day for departing from location). Vehicle engine size was assumed to be 550 horsepower (typical tractor trailer engine specifications [*Caterpillar 2006*]). Driving emissions are larger than idling emissions; therefore, all operation was assumed to be driving at full capacity.

Table 8.2.12-7: Combustion Emission Estimates from Light-Duty Trucks

Pollutant	Emission Factor[a]	Estimated Emissions[b]	
	g/mi	lb/day	tons/year
NOx	0.90	0.794	0.0010
CO	7.30	6.440	0.0060
$PM/PM_{10}/PM_{2.5}$	0.12	0.106	0.0001
VOC[c]	0.28	0.247	0.0002

CO = carbon monoxide; g/mi = grams per mile; lb/day = pounds per day; NOx = nitrogen oxides; PM = particulate matter; $PM_{2.5}$ = particulate matter up to 2.5 micrometers in diameter; PM_{10} = particulate matter up to 10 micrometers in diameter; VOC = volatile organic compound

[a] Emission factors taken from *40 Code of Federal Regulations 86.1811-04,* Table S04-1 (*Emission Standards for Light-Duty Vehicles, Light-Duty Trucks and Medium-Duty Passenger Vehicles*); emission limits were used as worst-case emission factors. Bin 11 vehicles were selected as worst-case scenario. Emission factors for PM, PM_{10}, and $PM_{2.5}$ were assume to be the same. SO_2 emission factors were not provided for light-duty trucks but these are expected to be negligible due to the likely use of fuels with low sulfur content.

[b] Emissions are estimated assuming one vehicle operates 8 hours per day, 2 days per year (one day for driving to location, one day for departing from location). Driving emissions are larger than idling emissions; therefore, all operation was assumed to be driving, with an average speed of 50 miles per hour.

[c] VOC emission factor assumed equal to non-methane organic compounds emission factor.

- Cell on Wheels: These projects could include a heavy-duty vehicle (large trailer) and mobile diesel generator. During deployment, the vehicle engines would power the vehicle while in motion on roadways (the diesel power generators are assumed to be off while the vehicle is in motion). Associated combustion emission estimates during the short-term deployment period (i.e., a few days) are presented in Table 8.2.12-6. If deployment (i.e., mobilization, setting up, and demobilization) lasted for 2 days per year (assume 8 hours per day), NOx emissions (as the worst-case pollutant) from a single Cell on Wheels/ heavy-duty vehicle would be approximately 0.022 ton. Additionally, annual PM_{10} emissions per unit of heavy-duty vehicle would be approximately 0.001 ton. Based on the assumptions stated in Table 8.2.12-6, the project would need to involve over 11,300 Cell on Wheels systems deploying for 2 days per year for NOx emissions to exceed the 250-tpy major source permitting threshold. More than 103,000 such systems would be needed to trigger general conformity requirements for PM_{10}. Should this amount of equipment be required during deployment (which is very unlikely), emissions could exceed the regulatory thresholds. As noted in Section 8.2.12.4, Potential Impacts of the Preferred Alternative, the mobile heavy-duty vehicles are not subject to major source permitting requirements. Therefore, only general conformity requirements could apply during deployment and only if a project is located in a nonattainment or maintenance area in Puerto Rico.
- Cell on Light Truck: These projects could include a light-duty truck and diesel power generator. Associated combustion emission estimates during the short-term deployment period (i.e., a few days) are presented in Table 8.2.12-7. If deployment (i.e., mobilization, setting up, and demobilization) lasted for 2 days per year (assume 8 hours per day), NOx emissions (as the worst-case pollutant) would be less than 0.001 ton from the mobile light-duty vehicle. Annual PM_{10} emissions would be approximately 0.0001 ton. Based on the assumptions stated in Table 8.2.12-7, the project would need to involve approximately 315,000 Cell on Light Truck systems deploying for 2 days per year for NOx emissions to exceed the 250-tpy major source permitting threshold. Approximately 945,000 such systems

would be needed to trigger general conformity requirements for PM_{10}. Should this amount of equipment be required during deployment (which is very unlikely), emissions could exceed the regulatory thresholds. As noted in Section 8.2.12.4, Potential Impacts of the Preferred Alternative, the mobile light-duty vehicles are not subject to major source permitting requirements; only general conformity requirements could apply during deployment and only if a project is located in a nonattainment or maintenance area in Puerto Rico.

- System on Wheels: These projects could include a heavy-duty vehicle (large trailer) and diesel power generator. Therefore, potential air quality impacts are expected to be similar to those for Cell on Wheels projects.
- Deployable Aerial Communications Architecture: These projects could involve mobilizing and demobilizing aerial vehicles including, but not limited to, unmanned aircraft such as drones and piloted aircraft such as airplanes and blimps. As indicated above, the deployment phase is only expected to occur over a few days. Potential air quality impacts of the long-term implementation of the Deployable Aerial Communications Architecture at the deployment location (some months to a year or more) are discussed in the Potential Operation Impacts section. These projects could involve fossil fuel combustion (e.g., drone, airplane, and blimp engines), but the associated combustion emissions would not be comparable to stationary source permitting thresholds. More detailed project information would be needed to model potential air emission impacts relative to local ambient air quality standards. However, most of the aerial vehicle emissions would occur at or above a few thousand feet above ground and are expected to dissipate before reaching ground level.

<u>Satellites and Other Technologies</u>

- Satellite-Enabled Devices and Equipment: Although it is expected that existing structures would be used, these projects could involve delivery and installation of equipment. The associated emissions can be estimated from the values in Table 8.2.12-4, although less equipment would likely be required, so emission estimates would likely be less than those values.

In general, the abovementioned activities could potentially involve fuel-burning construction equipment, dust from unpaved roads, first responder on-road vehicles, aerial platforms, and fossil fuel power generators. Increased air emissions associated with deployment of this infrastructure could potentially impact the surrounding community. However, increases in air emissions are not expected to exceed applicable major source permitting thresholds for the projects and potential air quality impacts are expected to be *less than significant* at the programmatic level and could be further minimized with BMPs and mitigation measures incorporated. In addition, it is anticipated that any air pollution increase due to deployment would likely be short-term with pre-existing air quality levels generally achieved after some months (typically less than a year and could be as short as a few hours or days for some activities). BMPs and mitigation measures to help reduce these potential deployment-related impacts are described in Chapter 11, BMPs and Mitigation Measures.

Potential Impacts for Increased Air Emissions

Based on the analysis of the deployment activities described above, potential impacts as a result of increased air emissions are anticipated to be *less than significant* at the programmatic level and could be further minimized with BMPs and mitigation measures incorporated for the deployment scenarios. See Chapter 11, BMPs and Mitigation Measures, for a listing of BMPs and mitigation measures that FirstNet and/or their partners would require, as practicable or feasible, to help avoid or minimize the potential air quality impacts.

Potential Operation Impacts

As described in Section 2.1.2, Proposed Action Infrastructure, operation activities associated with the Preferred Alternative would consist of routine maintenance and inspection of the facilities. Any major infrastructure replacement as part of ongoing system maintenance would result in potential impacts similar to the abovementioned potential deployment impacts. It is anticipated that there would be *less than significant* impacts at the programmatic level to air quality associated with routine inspections of the Preferred Alternative, assuming that the same access roads used for deployment are also used for inspections (i.e., air emissions would be infrequent and/or immeasurable). If use of heavy equipment or vehicles, outside of established access roads or corridors, occurs as part of routine maintenance or inspections, potential air quality impacts could result as explained above.

Operation activities associated with the Preferred Alternative could also involve the short-term (e.g., few weeks per year) operation of a fossil fuel-powered backup generator for wireless projects (e.g., to power a deployed antenna during upset conditions when commercial power is interrupted and during normal routine maintenance) as well as long-term (e.g., some months up to a year or more) operation of power generators (embedded in on-road vehicles) for land-based deployable technologies while stationed on-site. The types of infrastructure operation scenarios or activities that could be part of the Preferred Alternative and result in potential impacts to air quality include the following activities.

Wireless Projects

- New Wireless Communication Towers: Operation of these projects could involve the use of backup power generators, including those that operate by burning fossil fuels. Diesel-fueled backup power generators were assumed for this analysis; however, gasoline and hydrogen-fueled generators could be an option. The backup power generators would only operate during upset conditions when commercial power is interrupted and during normal routine maintenance (assumed a maximum of 500 hours per year for both upset conditions and normal routine maintenance). The diesel-fueled backup power generator emissions are provided in Table 8.2.12-8. Based on the assumptions stated in the table, these projects would need to involve at least 480 diesel generators rated 67 horsepower and running 500 hours per year, for any pollutant emissions (NOx) to exceed the 250-tpy major source permitting threshold. Over 2,700 such generators would be needed to trigger general conformity requirements for PM_{10}. Should these amounts of equipment be required (which is very unlikely), emissions could exceed the corresponding regulatory thresholds for major source permitting or general conformity.

- Collocation on Existing Wireless Tower, Structure, or Building: Operation of these projects would likely not involve the use of additional backup power generators during operations unless the existing backup generator power rating is not large enough for the collocation project. If additional backup power generator is required at the existing site, the potential operation impacts for these projects are expected to be similar to those associated with the New Wireless Communication Towers project (see Table 8.2.12-8).

Table 8.2.12-8: Combustion Emission Estimates from Diesel Backup Power Generators at Wireless Communication Towers

Pollutant	Emission Factor[a]	Estimated Emissions[b]	
	lb/hp-hr	lb/year	tons/year
NOx	0.03100	1,039.0	0.520
CO	0.00668	224.0	0.110
SOx	0.00205	68.7	0.034
$PM/PM_{10}/PM_{2.5}$	0.00220	73.7	0.037
VOC[c]	0.00251	84.2	0.042

CO = carbon monoxide; lb/hp-hr = pounds per horsepower-hour; lb/year = pounds per year; NOx = nitrogen oxides; PM = particulate matter; $PM_{2.5}$ = particulate matter up to 2.5 micrometers in diameter; PM_{10} = particulate matter up to 10 micrometers in diameter; SOx = sulfur oxides; VOC = volatile organic compound

[a] Emission factors taken from *AP-42, Compilation of Air Pollutant Emission Factors*, Section 3.3, Gasoline and Diesel Industrial Engines, Table 3.3-1 (diesel engines) (*USEPA 1996*). Emission factors for PM, PM_{10}, and $PM_{2.5}$ were assume to be the same.

[b] Emissions are estimated assuming one, 67-horsepower diesel engine operates for 500 hours per year when commercial power is interrupted and during normal routine maintenance. Estimates can be directly scaled based on actual equipment size and operating schedule.

[c] VOC emissions are assumed equal to total organic compound emissions.

Deployable Technologies

Operation of land-based deployable technologies while stationed on-site could involve the use of power generators embedded on heavy-duty vehicles (Cell on Wheels and System on Wheels) and/or light-duty trucks (Cell on Light Truck). During operations, the generators would power the cell unit while the vehicle is on-site and stationary (vehicle engines would likely be turned off on-site). Associated combustion emission estimates during the long-term operation period (i.e., some months up to a year or more) are presented in Table 8.2.12-9. If operation of the land-based deployment technologies lasted for 363 days per year (assumes 24-hour continuous operation excluding 2 days a year for mobilization, setting up, and demobilization as discussed in the Potential Deployment Impacts section), NOx emissions (as the worst-case pollutant) from a single power generator embedded in each land-based deployment technology (Cell on Wheels, Cell on Light Truck, or System on Wheels) would be approximately 4.32 tons. Additionally, annual PM_{10} emissions per unit of heavy-duty vehicle would be approximately 0.31 ton. The Preferred Alternative would need to involve at least 58 land-based deployable technology systems operating continuously and simultaneously for 363 days per year for NOx emissions to exceed the 250-tpy major source permitting threshold. Approximately 323 such systems would be needed to trigger general conformity for PM_{10}. Should these amounts of equipment be required during operations (which is very unlikely), emissions could exceed the regulatory thresholds.

Table 8.2.12-9: Combustion Emission Estimates from Diesel Generators on On-Road Vehicles

Pollutant	Emission Factor[a]	Estimated Emissions[b]	
	lb/hp-hr	lb/day	tons/year
NOx	0.03100	23.8	4.32
CO	0.00668	5.1	0.93
SOx	0.00205	1.6	0.29
PM/PM_{10}/$PM_{2.5}$	0.00220	1.7	0.31
VOC[c]	0.00251	1.9	0.35

CO = carbon monoxide; lb/day = pounds per day; lb/hp-hr = pounds per horsepower-hour; NOx = nitrogen oxides; PM = particulate matter; $PM_{2.5}$ = particulate matter up to 2.5 micrometers in diameter; PM_{10} = particulate matter up to 10 micrometers in diameter; SOx = sulfur oxides; VOC = volatile organic compound

[a] Emission factors taken from AP-42, *Compilation of Air Pollutant Emission Factors*, Section 3.3, Gasoline and Diesel Industrial Engines, Table 3.3-1 (diesel engines) (*USEPA 1996*). Emission factors for PM, PM_{10}, and $PM_{2.5}$ were assumed to be the same.

[b] Emissions are estimated assuming one, 300-horsepower diesel engine operates continuously (24 hours per day), 363 days per year (all year except for two travel days–see previous two tables). Estimates can be directly scaled based on actual equipment size and operating schedule.

[c] VOC emissions are assumed equal to total organic compound (TOC) emissions.

Operation of aerial vehicles such as drones, airplanes, and blimps could involve fossil fuel combustion (e.g., from their engines), but the associated combustion emissions would not be comparable to stationary source permitting thresholds. Helicopters are not expected to be used for operations activities. More detailed information on the Preferred Alternative would be needed to model potential air emission impacts relative to local ambient air quality standards. However, most of the aerial vehicle emissions would occur at or above a few thousand feet above ground and are expected to dissipate before reaching ground level.

In general, the abovementioned activities could potentially involve dust from unpaved roads and combustion emissions from first responder on-road vehicles, aerial platforms, and fossil fuel power generators. Increased air emissions associated with operation of this infrastructure could potentially impact the surrounding community. However, increases in air emissions are not expected to exceed applicable major source permitting thresholds for most deployment scenarios and potential air quality impacts are expected to be *less than significant* at the programmatic level and could be further minimized with BMPs and mitigation measures incorporated.

Based on the analysis of the operation activities described above, potential impacts as a result of increased air emissions are anticipated to be *less than significant* at the programmatic level and could be further minimized with BMPs and mitigation measures incorporated. To minimize the effects of the Preferred Alternative on air quality, FirstNet and/or their partners would require, as practicable or feasible, implementation of the same BMPs and mitigation measures as those required for potential deployment impacts (see Chapter 11, BMPs and Mitigation Measures).

8.2.12.5. Alternatives Impact Assessment

The following section assesses potential impacts to air quality associated with the Deployable Technologies Alternative and the No Action Alternative.[3]

Deployable Technologies Alternative

Under the Deployable Technologies Alternative option, a nationwide fleet of mobile communications systems would provide temporary coverage in areas not covered by the existing, usable infrastructure. There would be no collocation of equipment and no new construction associated with wired or wireless projects discussed above under the Preferred Alternative. Some limited construction could be associated with implementation such as land clearing or paving for parking or staging areas. The specific infrastructure associated with the Deployable Technologies Alternative would be the same as the deployable technologies implemented as part of the Preferred Alternative but would likely be implemented in greater numbers, over a larger geographic extent, and used with greater frequency and duration. Therefore, potential impacts to air quality as a result of implementation of this alternative could be as described below.

Potential Deployment Impacts

As explained above, implementation of deployable technologies could involve use of fossil fuel-powered generators, first responder on-road vehicles, and/or aerial platforms. Some staging or landing areas (depending on the type of technology) could require excavation and grading. In the event that a limited number of equipment units are needed (consistent with the assumptions described above for the potential deployment impacts), these projects are expected to be *less than significant* at the programmatic level and could be further minimized with BMPs and mitigation measures incorporated. However, should greater numbers of equipment or larger equipment be needed, potential impacts could become significant. These impacts could still be reduced through implementation of BMPs and mitigation measures described in Chapter 11, BMPs and Mitigation Measures.

Potential Operation Impacts

As explained above, operation activities would consist of implementation/running of the deployable technology and routine maintenance and inspections. As with the Preferred Alternative, it is anticipated that there would be *less than significant* impacts at the programmatic level to air quality associated with routine inspections of the Deployable Technologies Alternative, assuming that the same access roads used for deployment are also used for inspections, use of fossil fuel-powered generators could result in greater emissions than the Preferred Alternative (assuming more generators would be used) but would still result in *less than significant* impacts at the programmatic level and could be further minimized with BMPs and mitigation measures incorporated. If greater numbers of equipment or larger equipment are needed, potential impacts could become *potentially significant*. Potential impacts could be reduced through implementation of BMPs and mitigation measures described in

[3] As mentioned above and in Section 2.1.2, Proposed Action Infrastructure, the Preferred Alternative includes implementation of deployable technologies.

Chapter 11, BMPs and Mitigation Measures. If use of heavy equipment or vehicles outside of established access roads or corridors occurs as part of routine maintenance or inspections, additional potential air quality impacts could result as explained above. This alternative could also involve deploying aerial vehicles including, but not limited to, drones, blimps, and piloted aircraft, which could involve fossil fuel combustion. More information would be required regarding the number, type, and flight duration of the vehicles deployed to determine emissions from these technologies. However, most of the aerial vehicle emissions would occur at or above a few thousand feet above ground and are expected to dissipate before reaching ground level.

No Action Alternative

Under the No Action Alternative, the nationwide public safety broadband network would not be deployed; therefore there would be no associated construction or installation of wired, wireless, deployable infrastructure or satellites and other technologies. As a result, there would be *no impacts* to air quality because there would be no deployment or operation of the Proposed Action. Environmental conditions would therefore be the same as those described in Section 8.1.12, Air Quality.

8.2.13. Noise and Vibrations

8.2.13.1. Introduction

This section describes potential impacts from noise in Puerto Rico associated with deployment and operation of the Proposed Action. Mitigation measures, as defined through permitting and/or consultation with the appropriate resource agency, would be implemented as part of deployment and operation of the Proposed Action to help avoid or reduce potential impacts from noise. Implementation of best management practices (BMPs), as practicable or feasible, could further reduce the potential for impacts. Both mitigation measures and BMPs are discussed in Chapter 11, BMPs and Mitigation Measures. Unless otherwise stated, all references to noise in this section are airborne noise, specifically potential airborne noise impacts on humans. Potential airborne noise and vibration impacts on wildlife and underwater noise and vibration impacts on marine mammals and fish are discussed in Section 8.2.6, Biological Resources.

8.2.13.2. Impact Assessment Methodology and Significance Criteria

The potential impacts of the Proposed Action on noise and vibration were evaluated using the significance criteria presented in Table 8.2.13-1. As described in Section 8.2, Environmental Consequences, the categories of impacts are defined at the programmatic level as *potentially significant*, *less than significant with BMPs and mitigation measures incorporated*, *less than significant*, or *no impact*. Characteristics of the potential noise and vibration impact, including magnitude or intensity, geographic extent, and duration or frequency, were used to determine the impact significance rating associated with each potential impact.

Given the nature of this programmatic evaluation, and because the Proposed Action could potentially cover a wide variety of actions that would take place in various landscapes, the potential noise and vibration impacts addressed in this section are presented as a range of possible impacts.

Table 8.2.13-1: Impact Significance Rating Criteria for Noise and Vibrations

Type of Effect	Effect Characteristic	Impact Level			
		Potentially Significant	**Less than Significant with BMPs and Mitigation Measures Incorporated**	**Less than Significant**	**No Impact**
Increased noise and vibration levels	Magnitude or Intensity	Noise and vibration levels would exceed typical levels from construction equipment and generators. Noise levels at noise sensitive receptors (such as residences, hotels/motels/inns, hospitals, and recreational areas) would exceed 55 dBA or specific state/ territory noise limits. Noise levels plus baseline noise levels would exceed 10 dBA increase from baseline noise levels (i.e., louder). Vibration levels would exceed 65 VdB for human receptors and 100 VdB for buildings.	Effect that is *potentially significant*, but with mitigation and/or BMPs is *less than significant* at the programmatic level	Noise and vibration levels resulting from project activities would exceed natural sounds, but would not exceed typical levels from construction equipment or generators	Natural sounds would prevail. Noise and vibration generated by the action (whether it be construction or operation) would be infrequent or absent, mostly immeasurable.
	Geographic Extent	Municipality or local		Municipality or local	Municipality or local
	Duration or Frequency	Permanent or long-term		Short-term	Temporary

dBA = A-weighted decibel(s); VdB = vibration decibel(s)

8.2.13.3. Description of Environmental Concerns

Potential impacts to the community from increased noise and vibration levels could occur in a range of areas:

- Wilderness areas or pristine environments (including wildlife refuges, historic sites, ecological preserve areas, etc.) where natural quiet is expected;
- Rural and outer suburban areas with negligible traffic;
- General suburban areas with infrequent traffic, general suburban areas with medium density traffic; and
- Suburban areas with some commerce or industry.

These areas are most sensitive to increased noise and vibration levels because of their low to medium baseline day-night average noise levels, which typically range from 35 to 50 A-weighted decibels (dBA) (see Table 8.1.13-1), as well as background vibration levels that are generally not perceptible. Urban areas are less susceptible to increased noise and vibration levels because of their higher average ambient noise levels and overall human activity.

Increased noise and vibration levels could result in community annoyance by interfering with speech and other human-related activities. Noise emissions or vibrations associated with network deployment could potentially impact sensitive receptors (residences, hotels/motels/inns, hospitals, places of worship, schools, and recreational areas). The use of the following land-based and aerial deployable technologies could potentially impact such sensitive receptors:

- Wired and wireless technologies using heavy equipment such as excavators, backhoes, trenchers, graders, pavers, rollers, dump trucks, cranes, etc. required to support any construction/deployment activities;
- Land-based deployable technologies using power generators and first responder on-road vehicles (heavy –duty and light duty trucks or vans); and
- Aerial deployable technologies, such as unmanned aircraft (e.g., drones) and piloted aircraft (e.g., airplanes and blimps). Helicopters, if needed, would likely only be used during deployment to potentially move people or equipment to remote areas. As the use of helicopters would be infrequent, if at all, potential impacts associated with the use of helicopters are not evaluated here.

Because sensitive areas such as wilderness and pristine environments (e.g., El Toro Wilderness Area in El Yunque National Forest, Cabo Rojo National Wildlife Refuge [NWR], Culebra NWR, Desecheo NWR, Laguna Cartagena NWR, Vieques NWR), rural areas, and suburban areas are present throughout Puerto Rico, infrastructure could be built near these areas, in which case BMPs and mitigation measures (see Chapter 11, BMPs and Mitigation Measures) could help avoid or minimize the potential impacts related to noise and vibration. In addition, it is anticipated that any potential noise and vibration increases due to deployment would likely be isolated within those locations and would be short-term with pre-existing levels generally achieved after some months (typically less than a year and could be as short as a few hours or days for some activities such as pole construction).

8.2.13.4. Potential Impacts of the Preferred Alternative

The following section assesses potential impacts associated with implementation of the Preferred Alternative, including deployment and operation activities.

Potential Deployment Impacts

As described in Section 2.1.2, Proposed Action Infrastructure, implementation of the Preferred Alternative could result in the deployment of various types of facilities or infrastructure. Depending on the physical nature and location of the facility/infrastructure and the specific deployment requirements, some activities would result in potential noise and vibration impacts and others would not. In addition, and as explained in this section, various types of Preferred Alternative infrastructure would result in a range of *no impacts* to *less than significant* impacts depending on the deployment scenario or site-specific conditions. Site-specific analysis may be required depending on the site conditions, the type of deployment, or any other permits or permissions necessary to perform the work.

Activities Likely to Have No Impacts

Of the types of facilities or infrastructure development scenarios described in Section 2.1.2, Proposed Action Infrastructure, the following are likely to have *no impacts* to noise and vibration at the programmatic level under the conditions described below:

- Wired Projects
  - Use of Existing Conduit – New Buried Fiber Optic Plant: Although existing conduits would be used, these projects could involve equipment used for cable pulling and blowing. However, noise and vibration associated with this equipment would be infrequent and of a short duration and is not expected to produce perceptible impacts.
  - Use of Existing Buried or Aerial Fiber Optic Plant or Existing Submarine Cable: Lighting up of dark fiber would have *no impacts* related to noise and vibration at the programmatic level. It is expected that no heavy equipment would be used and no new structure would be installed or erected as most activities would be conducted in existing huts.
- Satellites and Other Technologies
  - Deployment of Satellites: FirstNet does not anticipate launching satellites as part of the deployment of the nationwide public safety broadband network (NPSBN); however, it could include equipment on satellites that are already being launched for other purposes. As adding equipment to an existing launch vehicle would be very unlikely to generate new noise and vibration impacts, it is anticipated that this activity would have no impact to those resources.

Activities with the Potential to Have Impacts

Potential deployment-related impacts to noise and vibration as a result of implementation of the Preferred Alternative would encompass a range of potential impacts that could occur from on-road and off-road engines of heavy equipment and during ground disturbance and installation activities. The types of infrastructure development scenarios or deployment activities that could be part of the Preferred Alternative and result in potential impacts to noise and vibration include the following:

Wired Projects

For buried wired projects, construction activities could include plowing (including vibratory plowing), trenching, or directional boring, depending on the nature of the terrain, geology, and environmental conditions. These activities could result in potential impacts to noise and vibration as a result of heavy equipment use during earth-work and material handling activities. Additional activities associated with buried wired projects include the installation of new or modified wired systems and the construction points of presence,[1] huts, or other associated facilities could result in noise and vibration increases. Limiting distances for maximum noise levels associated with these buried wired project-related activities under hard[2] and soft[3] ground conditions are presented in Table 8.2.13-2.

For aerial wired projects, construction activities could include new wiring and poles that require use of auger trucks, boom trucks, and bucket lifts, as well as excavation and grading for new or modified right-of-ways or easements. Similar to buried wired projects, additional activities associated with aerial wired projects include the installation of new or modifications to existing wired systems and the construction points of presence, huts, or other associated facilities could result in noise and vibration increases. Limiting distances for maximum noise levels associated with these aerial wired project-related activities under hard and soft ground conditions are presented in Table 8.2.13-3.

[1] Points of presence are connections or access points between two different networks, or different components of one network.

[2] A hard site exists where noise travels away from the source over a generally flat, hard surface such as water, concrete, hard-packed soil, or other ground surfaces having a low porosity. These are examples of reflective ground, where the ground does not provide any attenuation. The standard attenuation rate for hard site conditions is 6 dBA per doubling of distance for point source noise (e.g., power generators, most construction activities, etc.) and 3 dBA per doubling of distance for line sources (e.g., highway traffic, conveyor belt, etc.) (*WSDOT 2015*).

[3] A soft site exists where noise travels away from the source over porous ground or normal unpacked earth capable of absorbing noise energy such as grass, trees, or other ground surfaces suitable for the growth of vegetation, such as farmland. This type of site results in an additional 1.5 dBA reduction per doubling of distance at it spreads from the source. Added to the standard reduction rate for soft site conditions, point source noise attenuates at a rate of 7.5 dBA per doubling of distance, and line source noise decreases at a rate of 4.5 dBA per doubling of distance (*WSDOT 2015*).

In other cases, new buildings or structures could be required without the need for new or modified wired systems. In such cases, construction activities associated with the installation of transmission equipment would be required. Limiting distances[4] for maximum noise levels associated with transmission equipment installation under hard and soft ground conditions are presented in Table 8.2.13-4. The limiting distances for maximum vibration levels for all wired project types were not quantified, but are expected to be negligible.

Table 8.2.13-2: Limiting Distances for Maximum Noise Levels Associated with New Buried Wired Activities such as Plowing, Wire Installation, and Construction of Points of Presence and Fiber Huts

Noise Source[a,b]	Actual Measured Average Lmax at 50 Feet (dBA)[a]	Threshold Distance to 55 dBA Noise Criterion Under Hard Ground Conditions (Feet)[c]	Threshold Distance to 55 dBA Noise Criterion Under Soft Ground Conditions (Feet)[c]
Vibratory Plow[d]	80.0	889	500
Backhoe	78.0	706	416
Dozer	82.0	1,119	601
Flat-bed Truck	74.0	446	288
Pick-up Truck	75.0	500	315
Trench Roller[e]	80.0	889	500
Air Compressor	78.0	706	416
Cable Puller/Blower[f]	80.0	889	500
Concrete Mixer	79.0	792	456
Grader	89.0	2,506	1,145
Roller	80.0	889	500
Warning Horn	83.0	1,256	659
Total[g]	**92.6**	**3,788**	**1,594**

Lmax = maximum value of a noise level that occurs during a single event; dBA = A-weighted decibel
[a] Source: *WSDOT 2015*
[b] Maximum noise levels are based on operating one unit of typical equipment. It is not likely that more than one piece of each equipment type would be used at the same time. It is also unlikely that individual units of each equipment type listed in the table would be used concurrently; therefore, maximum noise levels and associated limiting distances presented in the table are conservative.
[c] Threshold distances to 55 dBA noise criterion were calculated in accordance with the equation and methodology (accounting for hard and soft ground conditions) described in *WSDOT 2015*. The calculations do not include the effects, if any, of atmospheric absorption, screening obstacles/barriers (e.g., earthen berm, buildings), or foliage that could reduce sound levels and limiting distances further.
[d] Lmax data for slurry trenching machine were assumed for vibratory plow.
[e] Lmax data for roller were assumed for trench roller.
[f] Lmax data for ventilation fan were assumed for cable puller/blower.
[g] Total Lmax, in this context, represents the logarithmic summation of individual Lmax levels. The total threshold distance represents the maximum extent of project-related noise under hard and soft ground conditions, i.e., at what distance from the source(s) the total maximum noise becomes indistinguishable from the 55 dBA noise criterion under hard and soft ground conditions.

[4] Limiting distances are distances beyond which an adverse effect would not occur.

Table 8.2.13-3: Limiting Distances for Maximum Noise Levels Associated with New Aerial Wired Activities such as Excavation, Grading, and Pole Delivery and Installation

Noise Source[a,b]	Actual Measured Average Lmax at 50 Feet (dBA)[a]	Threshold Distance to 55 dBA Noise Criterion Under Hard Ground Conditions (Feet)[c]	Threshold Distance to 55 dBA Noise Criterion Under Soft Ground Conditions (Feet)[c]
Grader	89.0	2,506	1,145
Suction Excavator	81.0	998	548
Auger Truck[d]	84.0	1,409	723
Boom Truck[e]	81.0	998	548
Cable Puller/Blower[f]	80.0	889	500
Bucket Lift[e]	81.0	998	548
Flat-bed Truck	74.0	446	288
Warning Horn	83.0	1,256	659
Total[g]	**92.4**	**3,717**	**1,570**

Lmax = maximum value of a noise level that occurs during a single event; dBA = A-weighted decibel

[a] Source: *WSDOT 2015*

[b] Maximum noise levels are based on operating one unit of typical equipment. It is not likely that more than one piece of each equipment type would be used at the same time. It is also unlikely that individual units of each equipment type listed in the table would be used concurrently; therefore, maximum noise levels and associated limiting distances presented in the table are conservative.

[c] Threshold distances to 55 dBA noise criterion were calculated in accordance with the equation and methodology (accounting for hard and soft ground conditions) described in *WSDOT 2015*. The calculations do not include the effects, if any, of atmospheric absorption, screening obstacles/barriers (e.g., earthen berm, buildings), or foliage that could reduce sound levels and limiting distances further.

[d] Lmax data for auger drill rig were assumed for auger truck.

[e] Lmax data for truck mounted crane were assumed for boom truck and bucket lift.

[f] Lmax data for ventilation fan were assumed for cable blower.

[g] Total Lmax, in this context, represents the logarithmic summation of individual Lmax levels. The total threshold distance represents the maximum extent of project-related noise under hard and soft ground conditions, i.e., at what distance from the source(s) the total maximum noise becomes indistinguishable from the 55 dBA noise criterion under hard and soft ground conditions.

Table 8.2.13-4: Limiting Distances for Maximum Noise Levels Associated with Tower, Structure, and Transmission Equipment Delivery and Installation

Noise Source[a,b]	Actual Measured Average Lmax at 50 Feet (dBA)[a]	Threshold Distance to 55 dBA Noise Criterion Under Hard Ground Conditions (Feet)[c]	Threshold Distance to 55 dBA Noise Criterion Under Soft Ground Conditions (Feet)[c]
Concrete Mixer	79.0	792	456
Flat-bed Truck	74.0	446	288
Grader	89.0	2,506	1,145
Paver	77.0	629	379
Roller	80.0	889	500
Truck Mounted Crane	81.0	998	548
Warning Horn	83.0	1,256	659
Total[d]	**91.4**	**3,296**	**1,426**

Lmax = maximum value of a noise level that occurs during a single event; dBA = A-weighted decibel
[a] Source: *WSDOT 2015*
[b] Maximum noise levels are based on operating one unit of typical equipment. It is not likely that more than one piece of each equipment type would be used at the same time. It is also unlikely that individual units of each equipment type listed in the table would be used concurrently; therefore, maximum noise levels and associated limiting distances presented in the table are conservative.
[c] Threshold distances to 55 dBA noise criterion were calculated in accordance with the equation and methodology (accounting for hard and soft ground conditions) described in *WSDOT 2015*. The calculations do not include the effects, if any, of atmospheric absorption, screening obstacles/barriers (e.g., earthen berm, buildings), or foliage that could reduce sound levels and limiting distances further.
[d] Total Lmax, in this context, represents the logarithmic summation of individual Lmax levels. The total threshold distance represents the maximum extent of project-related noise under hard and soft ground conditions, i.e., at what distance from the source(s) the total maximum noise becomes indistinguishable from the 55 dBA noise criterion under hard and soft ground conditions.

Wired project deployment would also involve other on-road vehicle use, including worker transportation to and from work sites. However, these ancillary activities would be temporary and would produce negligible noise pollution and vibration. Potential noise and vibration impacts associated with each type of wired project are discussed below:

- New Build – Buried Fiber Optic Plant: These projects could result in increased noise and vibration levels due to use of heavy equipment for plowing (including vibratory plowing), trenching, or directional boring, as well as the construction of points of presence, huts, or other associated facilities or hand-holes to access fiber. The limiting distances for maximum noise levels associated with new buried wired activities are presented in Table 8.2.13-2. The table excludes noise associated with trenching and horizontal boring activities as these are expected to be lower or similar to plowing activities (i.e., only one of the three options could occur at a particular location depending on the nature of the terrain, geology, and environmental conditions). As indicated in Table 8.2.13-2, a maximum noise level of 93 dBA at 50 feet could be expected from New Build – Buried Fiber Optic Plant projects, and residences or other sensitive receptors within 3,788 feet of these sources could be exposed to noise in excess of the 55 dBA criterion under hard ground conditions. Similarly, under soft ground conditions, residences or other sensitive receptors within 1,594 feet of these sources could be exposed to noise in excess of the 55 dBA criterion. Without BMPs and mitigation measures and/or if a wired project is situated in an area with low background sound levels such as wilderness area, pristine environments, rural areas, or suburban areas with infrequent traffic (see Table 8.1.13-1), the predicted maximum noise levels could substantially increase above background levels (i.e., 10 dBA or more above background levels), and residences and other sensitive receptors within these limiting distances could experience potential adverse noise impacts. To minimize the potential short-term noise impacts to residences and other sensitive receptors within these limiting distances, BMPs and mitigation measures would be implemented, as practicable or feasible, for New Build – Buried Fiber Optic Plant projects and other similar wired projects.

- New Build – Aerial Fiber Optic Plant: These projects would not require plowing, trenching, or directional boring. However, they could require construction of new wiring and poles, as well as excavation and grading for new or modified right-of-ways or easements, which could create noise and vibration impacts. The limiting distances for maximum noise levels associated with new buried wired activities are presented in Table 8.2.13-3. As indicated in the table, a maximum noise level of 92 dBA at 50 feet could be expected from New Build – Aerial Fiber Optic Plant projects, and residences or other sensitive receptors within 3,717 feet of these sources could be exposed to noise in excess of the 55 dBA criterion under hard ground conditions. Similarly, under soft ground conditions, residences or other sensitive receptors within 1,570 feet of these sources could be exposed to noise in excess of the 55 dBA criterion. These noise increases are similar but slightly smaller in magnitude than those associated with the New Build - Buried Fiber Optic Plant projects.
- Collocation on Existing Aerial Fiber Optic Plant: These projects would not require plowing, trenching, or directional boring. However, they could require replacement of existing wiring and poles (i.e., equipment installation). The maximum noise and vibration increases for these projects would be smaller in magnitude than those associated with the New Build - Aerial Fiber Optic Plant projects.
- New Build – Submarine Fiber Optic Plant: Potential impacts to airborne noise or ground vibrations could potentially occur as a result of the construction of landings and/or facilities on shore to accept submarine cable. Increased airborne noise is expected to result in similar potential noise impacts to the other New Build projects.
- Installation of Optical Transmission or Centralized Transmission Equipment: These projects could involve installation of boxes, huts, or other structures. Equipment delivery could require large trucks/trailers and installation could require cranes or skylifts. These projects could also require excavation and grading for new equipment and/or access roads, which could create noise and vibration impacts. The limiting distances for maximum noise levels associated with installation of transmission equipment are presented in Table 8.2.13-4. As indicated in the table, a maximum noise level of 92 dBA at 50 feet could be expected from these projects, and residences or other sensitive receptors within 3,656 feet of these sources could be exposed to noise in excess of the 55 dBA criterion under hard ground conditions. Similarly, under soft ground conditions, residences or other sensitive receptors within 1,549 feet of these sources could be exposed to noise in excess of the 55 dBA criterion. These noise increases are similar to those for the New Build –Aerial Fiber Optic Plant projects.

Wireless Projects

Wireless projects would involve similar, but fewer, noise and vibration sources than the previously discussed wired projects. Noise increases associated with installation of towers and other structures are comparable to the estimates in Table 8.2.13-4. Potential noise and vibration impacts associated with each type of wireless project are discussed below:

- New Wireless Communication Towers: These projects could involve installation of new wireless towers and associated structures (power generator and equipment sheds, fencing, security and aviation lighting, electrical feeds, and concrete foundations and pads). Installation noise levels are expected to correspond to those listed in Table 8.2.13-4. Therefore, a maximum noise level of 91 dBA at 50 feet could be expected from these projects and residences or other sensitive receptors within 3,296 feet of these sources could be exposed to noise in excess of the 55 dBA criterion under hard ground conditions. Similarly, under soft ground conditions, residences or other sensitive receptors within 1,426 feet of these sources could be exposed to noise in excess of the 55 dBA criterion. Without BMPs and mitigation measures and/or if a wireless project is situated in an area with low background sound levels such as wilderness area, pristine environments, rural areas, or suburban areas with infrequent traffic (see Table 8.1.13-1), the predicted maximum noise levels could substantially increase above background levels (i.e., 10 dBA or more above background levels) and residences and other sensitive receptors within these limiting distances could experience potential adverse noise impacts. BMPs and mitigation measures could be implemented for New Wireless Communication Towers projects and other similar wireless projects to further reduce potential impacts. The limiting distances for maximum vibration levels were not quantified, but are expected to be negligible.
- Collocation on Existing Wireless Tower, Structure, or Building: Collocation would involve mounting or installing equipment (such as antennas or microwave dishes) on an existing tower. Delivery and installation of equipment could require trucks and cranes that would generate noise and vibrations. Additionally, these projects could require some work on structure foundations and thus concrete mixing equipment. Because these projects would not involve installation of new wireless towers and associated structures, expected maximum noise increases and limiting distances to the 55 dBA criterion would be smaller in magnitude than those for the New Wireless Communication Towers project. Table 8.2.13-5 shows that a maximum noise level of 86 dBA at 50 feet could be expected from these projects, and residences or other sensitive receptors within 1,844 feet of these sources could be exposed to noise in excess of the 55 dBA criterion under hard ground conditions. Similarly, under soft ground conditions, residences or other sensitive receptors within 896 feet of these sources could be exposed to noise in excess of the 55 dBA criterion. The limiting distances for maximum vibration levels were not quantified, but are expected to be negligible.

Table 8.2.13-5: Limiting Distances for Maximum Noise Levels Associated with Collocation on Existing Wireless Tower, Structure, or Building

Noise Source[a,b]	Actual Measured Average Lmax at 50 Feet (dBA)[a]	Threshold Distance to 55 dBA Noise Criterion Under Hard Ground Conditions (Feet)[c]	Threshold Distance to 55 dBA Noise Criterion Under Soft Ground Conditions (Feet)[c]
Concrete Mixer	79.0	792	456
Flat-bed Truck	74.0	446	288
Truck Mounted Crane	81.0	998	548
Warning Horn	83.0	1,256	659
Total[d]	**86.3**	**1,844**	**896**

Lmax = maximum value of a noise level that occurs during a single event; dBA = A-weighted decibel
[a] Source: *WSDOT 2015*
[b] Maximum noise levels are based on operating one unit of typical equipment. It is not likely than more than one piece of each equipment type would be used at the same time. It is also unlikely that all individual units of each equipment type listed in the table would be used concurrently; therefore, maximum noise levels and associated limiting distances presented in the table are conservative.
[c] Threshold distances to 55 dBA noise criterion were calculated in accordance with the equation and methodology (accounting for hard and soft ground conditions) described in *WSDOT 2015*. The calculations do not include the effects, if any, of atmospheric absorption, screening obstacles/barriers (e.g., earthen berm, buildings), or foliage that could reduce sound levels and limiting distances further.
[d] Total Lmax, in this context, represents the logarithmic summation of individual Lmax levels. The total threshold distance represents the maximum extent of project-related noise under hard and soft ground conditions, i.e., at what distance from the source(s) the total maximum noise becomes indistinguishable from the 55 dBA noise criterion under hard and soft ground conditions.

Deployable Technologies

Implementation of deployable technologies could result in potential impacts to noise from use of power generators and first responder on-road vehicles and aerial platforms. On-road vehicles could include light-duty trucks for Cell on Light Truck projects or heavy-duty trucks for Cell on Wheels and System on Wheels projects. Aerial platforms could include drones, airplanes, balloons, and blimps, although it is not anticipated that balloons would generate noise or vibration impacts. In addition, some limited construction could be associated with the implementation of deployable technologies such as land clearing or paving for parking or staging areas. Limiting distances for maximum noise levels associated with deployable technologies during deployment (including mobilization to the destination site, setting up, and demobilization) are estimated in Table 8.2.13-6. The limiting distances for maximum vibration levels were not quantified, but are expected to be negligible for all deployable technologies.

Table 8.2.13-6: Limiting Distances for Maximum Noise Levels Associated with Deployable Technologies Implementation – Short-Term

Noise Source[a,b,c]	Actual Measured Average Lmax at 50 Feet (dBA)[a,b]	Threshold Distance to 55 dBA Noise Criterion Under Hard Ground Conditions (Feet)[d]	Threshold Distance to 55 dBA Noise Criterion Under Soft Ground Conditions (Feet)[d]
Cell on Wheels or System on Wheels			
Heavy-duty Vehicle or Large Trailer (1 Unit)[e]	76.0	561	346
Heavy-duty Vehicle or Large Trailer (2 Units)[e]	79.0	793	456
Heavy-duty Vehicle or Large Trailer (3 Units)[e]	80.8	792	537
Heavy-duty Vehicle or Large Trailer (4 Units)[e]	82.0	1,122	602
Heavy-duty Vehicle or Large Trailer (5 Units)[e]	83.0	1,254	659
Cell on Light Truck			
Light-duty Truck (1 Unit)[f]	75.0	500	315
Light-duty Truck (2 Units)[f]	78.0	707	416
Light-duty Truck (3 Units)[f]	79.8	866	490
Light-duty Truck (4 Units)[f]	81.0	1,000	549
Light-duty Truck (5 Units)[f]	82.0	1,118	601
Deployable Aerial Communication Architecture			
Unmanned Aircraft - Drone Takeoff or Landing (1 Unit)[g, h]	82.0	1,125	603
Unmanned Aircraft - Drone Take-off or Landing (2 Units)[g, h]	85.1	1,591	796
Unmanned Aircraft - Drone Take-off or Landing (3 Units)[g, h]	86.8	1,948	936
Unmanned Aircraft - Drone Take-off or Landing (4 Units)[g, h]	88.1	2,249	1,051
Unmanned Aircraft - Drone Take-off or Landing (5 Units)[g, h]	89.0	2,515	1,149
Piloted Aircraft - Plane Flyover (1 Unit)[i]	114.0	44,668	11,476
Piloted Aircraft - Plane Flyover (2 Units)[i]	117.0	63,171	15,143
Piloted Aircraft - Plane Flyover (3 Units)[i]	118.8	77,368	17,809
Piloted Aircraft - Plane Flyover (4 Units)[i]	120.0	89,337	19,981
Piloted Aircraft - Plane Flyover (5 Units)[i]	121.0	99,881	21,847
Piloted Aircraft - Blimps (1 Unit)[j]	85.6	1,687	835
Piloted Aircraft - Blimps (2 Units)[j]	88.6	2,386	1,101
Piloted Aircraft - Blimps (3 Units)[j]	90.3	2,922	1,295
Piloted Aircraft - Blimps (4 Units)[j]	91.6	3,374	1,453
Piloted Aircraft - Blimps (5 Units)[j]	92.6	3,772	1,589

Lmax = maximum value of a noise level that occurs during a single event; dBA = A-weighted decibel; NA = not applicable
[a] Source of Lmax data for Cell on Wheels, Cell on Light Truck, and System on Wheels: *WSDOT 2015*
[b] Source of Lmax data for Deployable Aerial Communication Architecture: *Hodgson et al. 2013* and *WSDOT 2015*
[c] Maximum noise levels for deployable technologies are based on operating one to five units of vehicle type, depending on the size of the coverage area.
[d] Threshold distances to 55 dBA noise criterion were calculated in accordance with the equation and methodology (accounting for hard and soft ground conditions) described in *WSDOT 2015*. The calculations do not include the effects, if any, of atmospheric absorption, screening obstacles/barriers (e.g., earthen berm, buildings), or foliage that could reduce sound levels and limiting distances further.

[e] Lmax data for dump truck were assumed for heavy-duty vehicle (large trailer).
[f] Lmax data for pick-up truck were assumed for light-duty truck.
[g] Lmax data for drone take-off were based on noise levels of a ScanEagle Unmanned Aerial Vehicle (85 to 90 dBA) at 6 meters (20 feet) (*Hodgson et al. 2013*). The 90 dBA maximum level at 20 feet was assumed for this analysis. The noise level at 20 feet was converted using typical logarithmic equations to reference noise levels at 50 feet.
[h] Lmax data for drone landing were assumed to equal to that for drone take-off.
[i] Lmax data for airplane flyover (120 dBA) at 1,000 feet were taken from *Purdue University 2015*. The noise level at 1,000 feet was converted using typical logarithmic equations to reference noise levels at 50 feet.
[j] Lmax data for blimps were based on noise levels of a Goodyear blimp with two 210-horsepower engines with a total of 110 dBA just outside of a gondola (assume 3 feet away) (*Goodyear Blimp 2015*). A gondola is a passenger compartment suspended beneath a balloon or airship. The 110 dBA maximum level at 3 feet was assumed for this analysis. The noise level at 3 feet was converted using typical logarithmic equations to reference noise levels at 50 feet.

This deployment phase is expected to occur over a few days. Potential noise impacts of the long-term implementation of this technology at the deployment location (some months to a year or more) are discussed in the operation impact section. Potential noise impacts associated with each type of deployable technology project are discussed below.

- Cell on Wheels: These projects could include noise sources such as a heavy-duty vehicle (with large trailer) and power generators. During deployment, the vehicle engines would power the vehicle while in motion on roadways (the power generators are assumed to be off while the vehicle is in motion). The limiting distances for maximum noise levels associated with Cell on Wheels projects during the short-term deployment period (i.e., a few days) are presented in Table 8.2.13-6. As indicated in the table, a maximum noise level of 76 dBA at 50 feet could be expected per unit of heavy-duty vehicle, and residences or other sensitive receptors within 561 feet of each heavy-duty vehicle could be exposed to noise in excess of the 55 dBA criterion under hard ground conditions. Similarly, under soft ground conditions, residences or other sensitive receptors within 346 feet of each heavy-duty vehicle could be exposed to noise in excess of the 55 dBA criterion. Without BMPs and mitigation measures and/or if a deployable technologies project is situated in an area with low background sound levels such as wilderness area, pristine environments, rural areas, or suburban areas with infrequent traffic (see Table 8.1.13-3), the predicted maximum noise levels could substantially increase above background levels (i.e., 10 dBA or more above background levels), and residences and other sensitive receptors within these limiting distances could experience potential adverse noise impacts. The expected maximum noise levels and limiting distances to the 55 dBA criterion during the short-term deployment period (i.e., a few days) is dependent on the type of deployed technology and the number of deployed units per affected area. For example, if Cell on Wheels technology were to be deployed in Puerto Rico (approximately 3,515 square miles) and assuming the Cell on Wheel technology can provide 10-mile diameter coverage, it would require approximately seven heavy-duty vehicles or large trailers to cover the entire territory. The maximum noise level associated with this land-based deployment technology (i.e., seven heavy-duty vehicles) in Puerto Rico would be approximately 85 dBA at 50 feet. Assuming mostly soft ground conditions in the territory (particularly the rural areas with farmland, grasses, trees, etc.), Puerto Rico residences or other sensitive receptors within 753 feet of the heavy-duty vehicles could be exposed to noise in excess of the 55 dBA criterion. To minimize the noise impacts to residences and other sensitive receptors within these limiting distances, BMPs and mitigation measures could be implemented for Cell on Wheels projects and other similar deployable technology projects.

- Cell on Light Truck: These projects could include a light-duty truck and power generator. As indicated above, generator noise is discussed in the operation impact section. The expected maximum noise levels and limiting distances to the 55 dBA criterion during the short-term deployment period (i.e., a few days) is dependent on the type of deployed technology and the number of deployed units per affected area (Table 8.2.13-6). For example, if Cell on Light Truck technology were to be deployed in Puerto Rico (approximately 3,515 square miles) and assuming the Cell on Light Truck technology can provide 2-mile diameter coverage, it would require approximately 34 light-duty trucks to cover the entire territory. The maximum noise level associated with this land-based deployment technology (i.e., 34 light-duty trucks) in Puerto Rico is approximately 90 dBA at 50 feet. Assuming mostly soft ground conditions in the territory (particularly the rural areas with farmland, grasses, trees, etc.), Puerto Rico residences or other sensitive receptors within 1,293 feet of the light-duty trucks could be exposed to noise in excess of the 55 dBA criterion.
- System on Wheels: These projects could include a heavy-duty vehicle (large trailer) and power generator (i.e., same noise sources as Cell on Wheels technology). As indicated above, the generator noise is discussed in the operation impact section. Therefore, expected maximum noise levels and limiting distances to the 55 dBA criterion would be similar to those for the Cell on Wheels projects (Table 8.2.13-6).
- Deployable Aerial Communications Architecture: These projects could involve mobilizing and demobilizing aerial vehicles, including, but not limited to, drones, airplanes, balloons, and blimps. As indicated above, the deployment phase is only expected to occur over a few days. Potential noise impacts of the long-term implementation of the Deployable Aerial Communications Architecture at the deployment location are discussed in the operation impact section. The aerial vehicles typically generate loud noises during take-off and landing operations. During the short-term deployment period (i.e., a few days), the maximum noise levels for a single aerial vehicle take-off or landing are expected to range from 82 dBA at 50 feet for a drone to 114 dBA at 50 feet for an airplane. As such, residences or other sensitive receptors within 1,125 to 44,668 feet (0.21 to 8.5 miles) of these aerial vehicles could be exposed to noise in excess of the 55 dBA criterion under hard ground conditions. Similarly, under soft ground conditions, residences or other sensitive receptors within 603 to 11,476 feet (o.11 to 2.2 miles) of these aerial vehicles could be exposed to noise in excess of the 55 dBA criterion (Table 8.2.13-6). It is unlikely that take-off or landing of aerial vehicles would occur concurrently at the same location; however, if this were to occur, total noise increases and limiting distances to the 55 dBA criterion would increase as well (Table 8.213-6). For overflight operations, most of the noise would occur at a few thousand feet above ground level and could be perceived by sensitive receptors on the ground but for a short-term/intermittent period.

The short-term and intermittent noise increases associated with the aerial vehicles take-off and landings would be higher than those for the Cell on Wheels, Cell on Light Truck, and System on Wheels projects. The expected maximum noise levels and limiting distances for the 55 dBA criterion during the short-term deployment period (i.e., few days) is dependent on the type of deployed aerial technology and the number of deployed units per affected area. For example, if an unmanned aircraft such as a drone were to be deployed in or near El Yunque National Forest (approximately 44.43 square miles) and assuming the drone can provide 15-mile diameter coverage, it would require only one drone to cover the entire national forest.

The maximum noise level associated with this Deployable Aerial Communication Architecture (i.e., the single drone taking off or landing) in or near El Yunque National Forest would be approximately 82 dBA at 50 feet. Because the ground conditions at national forests and wilderness areas are typically soft (grasses, trees, etc.), sensitive receptors within 603 feet (0.11 mile) of the single drone take-off and landing could be exposed to noise in excess of the 55 dBA criterion. If piloted aircraft are used, the corresponding noise levels would be higher and sensitive receptors at larger distances from the source (piloted aircraft) would be exposed to noise above 55 dBA. For example, if a piloted aircraft such as a two-engine airplane were to be deployed in or near El Yunque National Forest (44.43 square miles) and assuming the two-engine airplane can also provide 15-mile diameter coverage, it would require only a single two-engine airplane to cover the entire forest. The maximum noise level associated with this Deployable Aerial Communication Architecture (i.e., the single two-engine airplane taking off or landing) in or near El Yunque National Forest would be approximately 114 dBA at 50 feet. Because the ground conditions at national forests and wilderness areas are typically soft (grasses, trees, etc.), sensitive receptors within 11,476 feet (2.2 miles) of the single two-engine airplane take-off or landing could be exposed to noise in excess of the 55 dBA criterion.

<u>Satellites and Other Technologies</u>

- Satellite-Enabled Devices and Equipment: Although it is expected that existing structures would be used, these projects could involve delivery and installation of equipment. The associated noise increases can be estimated from the values in Table 8.2.13-4 above, although less equipment would likely be required, so noise increases and limiting distances to the 55 dBA criterion under hard and soft ground conditions would likely be less than those values. Vibration impacts, if any, would be negligible.

Increased Noise and Vibration Levels during Deployment

In general, the abovementioned activities could potentially involve heavy equipment movement associated with ground disturbance, equipment delivery, and installation, as well as operation of power generators, and first responder on-road vehicles, and aerial platforms. Increased noise levels associated with deployment of this infrastructure could potentially impact the surrounding community. BMPs and mitigation measures could help reduce these potential impacts during deployment activities. Based on the analysis of the deployment activities described above, potential impacts as a result of increased noise levels are anticipated to be *less than significant* at the programmatic level since these potential impacts would generally be temporary and limited to areas near deployment locations. See Chapter 11, BMPs and Mitigation Measures, for a listing of BMPs and mitigation measures that FirstNet and/or their partners would require, as practicable or feasible, to help avoid or minimize potential noise impacts. Impacts from vibrations are expected to be negligible.

Potential Operation Impacts

As described in Section 2.1.2, Proposed Action Infrastructure, operation activities associated with the Preferred Alternative would consist of routine maintenance and inspection of the facilities. Any major infrastructure replacement as part of ongoing system maintenance would result in potential impacts similar to the abovementioned potential deployment impacts. It is anticipated that there would be minimal potential impacts to noise and vibration associated with routine inspections of the Preferred Alternative, assuming that the same access roads used for deployment are also used for inspections (i.e., noise from pick-up truck driven by inspector would be infrequent and/or immeasurable). If use of heavy equipment as part of routine maintenance or inspections occurs off of established access roads or corridors, potential noise and vibration impacts could result as explained above.

Operation activities associated with the Preferred Alternative could also involve prolonged operation of a fossil fuel-powered generator (e.g., to power a deployed antenna), aerial vehicles (e.g., drones, airplanes, balloons, and blimps), and other support equipment such as ventilation fans associated with heating, ventilation, and air cooling at fiber huts or central offices. Helicopters are not expected to be used for operations activities. Such operation would result in increased noise and vibration levels over extended periods. The types of infrastructure operation scenarios or activities that could be part of the Preferred Alternative and result in potential impacts to noise and vibrations include the following:

Wireless Projects

- New Wireless Communication Towers: Operation of these projects could involve the use of power generators and ventilation fans at fiber huts or central offices. Table 8.2.13-7 indicates a maximum noise level of 83 dBA at 50 feet could be expected from extended use of power generators and ventilation fans and as such, residences or other sensitive receptors within 1,274 feet of these sources could be exposed to noise in excess of the 55 dBA criterion under hard ground conditions. Similarly, under soft ground conditions, residences or other sensitive receptors within 667 feet of these sources could be exposed to noise in excess of the 55 dBA criterion. Without BMPs and mitigation measures and/or if a wireless project is situated in an area with low background sound levels such as wilderness areas, pristine environments, rural areas, or suburban areas with minimum traffic (see Table 8.1.13-3), the predicted maximum noise levels could substantially increase above background levels (i.e., 10 dBA or more above background levels) and residences and other sensitive receptors within these limiting distances could experience potential adverse noise impacts. To minimize the potential long-term noise impacts to residences and other sensitive receptors within these limiting distances, BMPs and mitigation measures could be implemented, as practicable or feasible, for New Wireless Communication Towers projects and other similar wireless projects. The limiting distances for maximum vibration levels were not quantified, but are expected to be negligible.

- Collocation on Existing Wireless Tower, Structure, or Building: In the event that additional onsite backup power is required for reasons of FirstNet's requirements for resiliency and redundancy, operation of these projects could involve the use of power generators (Table 8.2.13-7). If additional power generators are required, the potential operation impacts for these projects are expected to be similar but slightly less than those associated with the New Wireless Communication Towers project. If additional power generators are not required, the potential operation noise and vibration impact for these projects would be negligible.

Table 8.2.13-7: Limiting Distances for Maximum Noise Levels Associated with Power Generators and Ventilation Fans at Fiber Huts or Central Offices

Noise Source[a,b]	Actual Measured Average Lmax at 50 Feet (dBA)[a]	Threshold Distance to 55 dBA Noise Criterion Under Hard Ground Conditions (Feet)[c]	Threshold Distance to 55 dBA Noise Criterion Under Soft Ground Conditions (Feet)[c]
Power Generator	81.0	998	548
Ventilation Fan	79.0	792	456
Total[d]	**83.1**	**1,274**	**667**

Lmax = maximum value of a noise level that occurs during a single event; dBA = A-weighted decibel
[a] Source: *WSDOT 2015*
[b] Maximum noise levels are based on operating one unit of typical equipment. It is not likely that more than one piece of each equipment type would be used at the same time. It is also unlikely that individual units of each equipment type listed in the table would be used concurrently; therefore, maximum noise levels and associated limiting distances presented in the table are conservative.
[c] Threshold distances to 55 dBA noise criterion were calculated in accordance with the equation and methodology (accounting for hard and soft ground conditions) described in *WSDOT 2015*. The calculations do not include the effects, if any, of atmospheric absorption, screening obstacles/barriers (e.g., earthen berm, buildings), or foliage that could reduce sound levels and limiting distances further.
[d] Total Lmax, in this context, represents the logarithmic summation of individual Lmax levels. The total threshold distance represents the maximum extent of project-related noise under hard and soft ground conditions, i.e., at what distance from the source(s) the total maximum noise becomes indistinguishable from the 55 dBA noise criterion under hard and soft ground conditions.

Deployable Technologies

Operation of land-based deployable technologies while stationed-onsite could involve the use of power generators embedded in heavy-duty vehicles (Cell on Wheels and System on Wheels) and/or light duty trucks (Cell on Light Truck) (Table 8.2.13-8). As indicated in the table, a maximum noise level of approximately 61 dBA at 50 feet could be expected per unit of power generator, and residences or other sensitive receptors within 103 feet of these sources could be exposed to noise in excess of the 55 dBA criterion under hard ground conditions. Similarly, under soft ground conditions, residences or other sensitive receptors within 89 feet of each power generator could be exposed to noise in excess of the 55 dBA criterion.

The expected maximum noise levels and limiting distances to the 55 dBA criterion during the long-term deployment period (i.e., some months to a year or more) is dependent on the type of deployed land-based technology and the number of deployed units per affected area. As an example, if Cell on Wheels technology were to be deployed in the Puerto Rico territory (approximately 3,515 square miles) and assuming the Cell on Wheel technology can provide 10 mile diameter coverage, it would require approximately seven power generators (embedded in heavy-duty vehicles or large trailers) to cover the entire territory. The maximum noise level associated with this land-based deployment technology (i.e., seven power generators) in Puerto Rico would be approximately 70 dBA at 50 feet. Assuming mostly soft ground conditions in the territory (particularly the rural areas with farmland, grasses, trees, etc.), Puerto Rico residences or other sensitive receptors within 194 feet of the power generators could be exposed to noise in excess of the 55 dBA criterion.

These projects could involve aerial vehicles, including, but not limited to, drones, airplanes, balloons, and blimps, although it is not anticipated that balloons would generate noise or vibration impacts. Aerial vehicle take-off and landing operations typically generate loud noises. The magnitude of noise generated by these aerial vehicles would be similar to those described in the short-term deployment phase but would occur over a longer period (i.e., some months to a year or more). During the long-term deployment period, the maximum noise level is expected to range from approximately 82 dBA at 50 feet for a drone take-off or landing to 114 dBA at 50 feet for an airplane. As such, residences or other sensitive receptors within 1,125 and 44,668 feet (0.21 to 8.5 miles) of each aerial vehicle take-off or landing could be exposed to noise in excess of the 55 dBA criterion under hard ground conditions. Similarly, under soft ground conditions, residences or other sensitive receptors within 603 to 11,476 feet (0.11 to 2.2 miles) of each aerial vehicle operation could be exposed to noise in excess of the 55 dBA criterion (Table 8.2.13-8). It is unlikely that take-off and landing of aerial vehicles would occur concurrently at the same location; however, if this were to occur, total noise increases and limiting distances to the 55 dBA criterion would increase as well (Table 8.2.13-8). For overflight operations, most of the aerial vehicle noise would occur at a few thousand feet above ground level and could be perceived by sensitive receptors on the ground but for a short-term/intermittent period. The short-term and intermittent noise increases associated with the aerial vehicle take-off and landing would be higher than those for the land-based deployment technologies.

Table 8.2.13-8: Limiting Distances for Maximum Noise Levels Associated with Deployable Technologies Implementation – Long-Term

Noise Source[a,b,c]	Actual Measured Average Lmax at 50 Feet (dBA)[a,b]	Threshold Distance to 55 dBA Noise Criterion Under Hard Ground Conditions (Feet)[d]	Threshold Distance to 55 dBA Noise Criterion Under Soft Ground Conditions (Feet)[d]
Cell on Wheels, Cell on Light Truck, or System on Wheels			
Power Generator (1 Unit)	61.3	103	89
Power Generator (2 Units)	64.3	145	117
Power Generator (3 Units)	66.0	178	138

Noise Source[a,b,c]	Actual Measured Average Lmax at 50 Feet (dBA)[a,b]	Threshold Distance to 55 dBA Noise Criterion Under Hard Ground Conditions (Feet)[d]	Threshold Distance to 55 dBA Noise Criterion Under Soft Ground Conditions (Feet)[d]
Power Generator (4 Units)	67.3	205	155
Power Generator (5 Units)	68.2	230	169
Deployable Aerial Communication Architecture			
Unmanned Aircraft - Drone Takeoff or Landing (1 Unit)[e,f]	82.0	1,125	603
Unmanned Aircraft - Drone Takeoff or Landing (2 Units)[e,f]	85.1	1,591	796
Unmanned Aircraft - Drone Takeoff or Landing (3 Units)[e,f]	86.8	1,948	936
Unmanned Aircraft - Drone Takeoff or Landing (4 Units)[e,f]	88.1	2,249	1,051
Unmanned Aircraft - Drone Takeoff or Landing (5 Units)[e,f]	89.0	2,515	1,149
Piloted Aircraft - Plane Flyover (1 Unit)[g]	114.0	44,668	11,476
Piloted Aircraft - Plane Flyover (2 Units)[g]	117.0	63,171	15,143
Piloted Aircraft - Plane Flyover (3 Units)[g]	118.8	77,368	17,809
Piloted Aircraft - Plane Flyover (4 Units)[g]	120.0	89,337	19,981
Piloted Aircraft - Plane Flyover (5 Units)[g]	121.0	99,881	21,847
Piloted Aircraft - Blimps (1 Unit)[h]	85.6	1,687	835
Piloted Aircraft - Blimps (2 Units)[h]	88.6	2,386	1,101
Piloted Aircraft - Blimps (3 Units)[h]	90.3	2,922	1,295
Piloted Aircraft - Blimps (4 Units)[h]	91.6	3,374	1,453
Piloted Aircraft - Blimps (5 Units)[h]	92.6	3,772	1,589

Lmax = maximum value of a noise level that occurs during a single event; dBA = A-weighted decibel; NA = not applicable
[a] Source of Lmax data for Cell on Wheels, Cell on Light Truck, and System on Wheels: *WSDOT 2015*
[b] Source of Lmax data for Deployable Aerial Communication Architecture: *Hodgson et al. 2013* and *WSDOT 2015*
[c] Maximum noise levels for deployable technologies are based on operating one to five units of vehicle type, depending on the size of the coverage area.
[d] Threshold distances to 55 dBA noise criterion were calculated in accordance with the equation and methodology (accounting for hard and soft ground conditions) described in *WSDOT 2015*. The calculations do not include the effects, if any, of atmospheric absorption, screening obstacles/barriers (e.g., earthen berm, buildings), or foliage that could reduce sound levels and limiting distances further.
[e] Lmax data for drone take-off were based on noise levels of a ScanEagle Unmanned Aerial Vehicle (85 to 90 dBA) at 6 meters (20 feet) (*Hodgson et al. 2013)*. The 90 dBA maximum level at 20 feet was assumed for this analysis. The noise level at 20 feet was converted using typical logarithmic equations to reference noise levels at 50 feet.
[f] Lmax data for drone landing were assumed to equal to that for drone take-off.
[g] Lmax data for airplane flyover (120 dBA) at 1,000 feet were taken from *Purdue University2015*. The noise level at 1,000 feet was converted using typical logarithmic equation to reference noise levels at 50 feet.
[h] Lmax data for blimps were based on noise levels of a Goodyear blimp with two 210-horsepower engines with a total of 110 dBA just outside of a gondola (assume 3 feet away) (*Goodyear Blimp 2015*). A gondola is a passenger compartment suspended beneath a balloon or airship. The 110 dBA maximum level at 3 feet was assumed for this analysis. The noise level at 3 feet was converted using typical logarithmic equations to reference noise levels at 50 feet.

The expected maximum noise levels and limiting distances to the 55 dBA criterion during the long-term deployment period (i.e., some months to a year or more) is dependent on the type of deployed aerial technology and the number of deployed units per affected area. For example, if an unmanned aircraft such as a drone were to be deployed in or near El Yunque National Forest (approximately 44.43 square miles) and assuming the drone can provide 15-mile diameter coverage, it would require only one drone to cover the entire national forest. The maximum noise level associated with this Deployable Aerial Communication Architecture (i.e., the single drone taking off or landing) in or near El Yunque National Forest would be approximately 82 dBA at 50 feet. Because the ground conditions at national forests and wilderness areas are typically soft (grasses, trees, etc.), sensitive receptors within 603 feet (0.11 mile) of the single drone could be exposed to noise in excess of the 55 dBA criterion. If piloted aircraft are used, the corresponding noise levels would be higher and sensitive receptors at larger distances from the source (piloted aircraft) would be exposed to noise above 55 dBA. For example, if a piloted aircraft such as a two-engine airplane were to be deployed in or near El Yunque National Forest (approximately 44.43 square miles) and assuming the two-engine airplane can also provide 15-mile diameter coverage, it would require only a single two-engine airplane to cover the entire park. The maximum noise level associated with this Deployable Aerial Communication Architecture (i.e., the single two-engine airplane taking off or landing) in or near El Yunque National Forest would be approximately 114 dBA at 50 feet. Because the ground conditions at national forests and wilderness areas are typically soft (grasses, trees, etc.), sensitive receptors within 11,476 feet (2.2 miles) of the single two-engine airplane take-off or landing could be exposed to noise in excess of the 55 dBA criterion. The limiting distances for maximum vibration levels for operation of deployable technologies (e.g., from power generators) were not quantified, but are expected to be negligible.

Increased Noise and Vibration Levels during Operation

In general, the abovementioned activities could potentially generate noise from extended use of power generators, and aerial vehicles. Increased noise levels associated with operation of this infrastructure could potentially impact the surrounding community. BMPs and mitigation measures could help reduce these potential impacts during operation activities.

Based on the analysis of the operation activities described above, potential impacts as a result of increased noise and vibration levels are anticipated to be *less than significant* at the programmatic level. To minimize the effects of the Preferred Alternative on noise and vibration during operation activities, FirstNet and/or their partners would require, as practicable or feasible, implementation of BMPs and mitigation measures described in Chapter 11.

8.2.13.5. Alternatives Impact Assessment

The following section assesses potential impacts to noise associated with the Deployable Technologies Alternative and the No Action Alternative.[5]

Deployable Technologies Alternative

Under the Deployable Technologies Alternative, a nationwide fleet of mobile communications systems would provide temporary coverage in areas not covered by the existing, usable infrastructure. There would be no collocation of equipment and no new construction associated with wired or wireless projects discussed above under the Preferred Alternative. Some limited construction could be associated with implementation such as land clearing or paving for parking or staging areas. The specific infrastructure associated with the Deployable Technologies

[5] As mentioned above and in Section 2.1.2, Proposed Action Infrastructure, the Preferred Alternative includes implementation of deployable technologies.

Alternative would be the same as the deployable technologies implemented as part of the Preferred Alternative but would likely be implemented in greater numbers, over a larger geographic extent, and used with greater frequency and duration. Therefore, potential impacts from noise and vibration as a result of implementation of this alternative could be as described below.

Potential Deployment Impacts

As explained above, implementation of deployable technologies would result in *less than significant* potential impacts to noise and vibration at the programmatic level if deployment requires use of heavy equipment, power generators, first responder on-road vehicles, and/or aerial platforms. Some staging or landing areas (depending on the type of technology) could require land/vegetation clearing, minimal excavation, and paving. In comparison to the Deployable Technologies Alternative implemented as part of the Preferred Alternative (Table 8.2.13-6), these activities would likely be implemented in greater number over a larger geographic extent, and used in greater frequency and duration. Therefore, the maximum noise increases and limiting distances to sensitive receptors for this alternative are expected to be greater in magnitude than those listed in Table 8.2.13-6. These activities would result in increased noise levels as well, but again these potential impacts are expected to be *less than significant* at the programmatic level.

Potential Operation Impacts

As explained above, operation activities would consist of implementation/running of the deployable technology and routine maintenance and inspections. As with the Preferred Alternative, it is anticipated that potential noise and vibration impacts associated with routine inspections of the Deployable Technologies Alternative, assuming that the same access roads used for deployment are also used for inspections, and the use of power generators, aerial vehicles, and ventilation fans on fiber huts or central offices are expected to be *less than significant* at the programmatic level. If use of heavy equipment or vehicles outside of established access roads or corridors occurs as part of routine maintenance or inspections, potential noise and vibration impact could result as explained above.

No Action Alternative

Under the No Action Alternative, the NPSBN would not be deployed; therefore there would be no associated construction or installation of wired, wireless, deployable infrastructure or satellites and other technologies. As a result, there would be no noise and vibration impacts because there would be no deployment or operation of the Proposed Action. Environmental conditions would therefore be the same as those described in Section 8.1.13, Noise.

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8.2.14. Climate Change

8.2.14.1. Introduction

This section presents future climate change projections for temperature, precipitation, and sea-level rise (SLR). It also describes, as a proxy for assessing the potential impact of the Proposed Action on climate change, potential greenhouse gas (GHG) emissions arising from deployment and operation of the Proposed Action, as well as the effects of climate change in Puerto Rico on the Proposed Action. Best management practices (BMPs) and mitigation measures that would avoid or minimize those potential impacts are addressed in Chapter 11, BMPs and Mitigation Measures. Mitigation measures, as defined through permitting and/or consultation with the appropriate resource agency, would be implemented as part of deployment and operation of the Proposed Action to help avoid or reduce potential GHG emissions arising from deployment and operation of the Proposed Action and potential impacts on the Proposed Action as a result of climate change. Implementation of best management practices (BMPs), as practicable or feasible, could further reduce the potential for impacts. Both mitigation measures and BMPs are discussed in Chapter 11, BMPs and Mitigation Measures

8.2.14.2. Impact Assessment Methodology and Significance Criteria

The potential impacts of climate change on the Proposed Action were evaluated using the significance criteria presented in Table 8.2.14-1. As described in Section 8.2, Environmental Consequences, the categories of impacts are defined at the programmatic level as *potentially significant*, *less than significant with BMPs and mitigation measures incorporated*, *less than significant*, or *no impact*. Characteristics of the potential effects of climate change on the Proposed Action, including magnitude or intensity, geographic extent, and duration or frequency, were used to determine impact significance ratings. Since this is a programmatic assessment and site-specific locations or deployment technology are not known, it is not possible to determine the magnitude or intensity, geographic extent, and duration or frequency of the Proposed Action's contribution to climate change through GHG emissions. However, an assessment of potential impacts is provided in this section based on the potential emissions associated with the various activities that could occur. Further assessment of GHG emissions could be performed once site-specific details become available, such as site conditions, the type of deployment, and any permits or permissions necessary to perform the work.

Given the nature of this programmatic evaluation, and because the Proposed Action could potentially cover a wide variety of actions that would take place in various landscapes, the potential impacts of climate change on the Proposed Action and the potential GHG emissions arising from the Proposed Action are addressed in this section as a range of possible impacts.

Table 8.2.14-1: Impact Significance Rating Criteria for Climate Change

Type of Effect	Effect Characteristic	Impact Level			
		Potentially Significant	**Less than Significant with BMPs and Mitigation Measures Incorporated**	**Less than Significant**	**No Impact**
Contribution to climate change through GHG emissions	Magnitude or Intensity	See discussion below in Section 8.2.14.6, Potential Impacts of the Preferred Alternative			There would be no increase in GHG emissions or related changes to the climate as a result of the Proposed Action activities
	Geographic Extent				NA
	Duration or Frequency				NA
Effect of climate change on Proposed Action-related impacts	Magnitude or Intensity	Local impacts from global climate change effects are observed in air temperature rise; precipitation increases (severe storm events), and/or sea level	Effect that is *potentially significant*, but with BMPs and mitigation measures is *less than significant* at the programmatic level	Only slight change observed	There would be no measurable changes in global average temperature, precipitation events including severe storms, or sea-level rise
	Geographic Extent	Local impacts from global climate change effects are observed		Local impacts from global climate change effects are observed.	NA
	Duration or Frequency	Long-term changes; changes cannot be reversed in a short term		Long-term changes; changes cannot be reversed in a short term	NA

GHG = greenhouse gas; CO_2e = carbon dioxide equivalents; NA = not applicable

8.2.14.3. Global Climate Change Effects

Global climate change due to increasing GHG emissions is projected to produce a range of effects including changes in temperature and precipitation on a seasonal and annual basis, and in sea level compared to historical trends. Additional effects could include intensity and frequency of weather events such as storms, tornados, and droughts. Climate change projections are developed by simulating different future emission scenarios with a variety of models that are calibrated using historical trends plus the influence of varying radiative forcing[1] index due to increase in concentration of GHGs in the atmosphere. Global circulation models are frequently used to make global high level projections of temperature, precipitation, and other parameters. These models can be downscaled to produce regional climate models. Downscaling refers to disaggregating and refining future predictions from global to regional levels.

As part of this Final Programmatic Environmental Impact Statement, an analysis was conducted to evaluate potential effects of overall climate change in Puerto Rico. The potential climate change impacts associated with the Proposed Action are evaluated in Section 8.2.14.6, Potential Impacts of the Preferred Alternative. The analysis identified relevant and credible sources for climate change projections in the region potentially affected by the Proposed Action. The projections analyzed were downscaled from global general circulation models. Due to the broad geography of the Proposed Action, three studies were reviewed as part of this analysis:

- *Fifth Assessment Report, International Panel on Climate Change*: the fifth assessment report provides global and regional climate change projections and sector specific climate risks.
- *Third National Climate Assessment, United States Global Change Research Program*: The third National Climate Assessment (NCA) provided downscaled climate change projections and impacts covering the U.S. and its territories.
- *Climate of the Southeast United States: Variability, Change, Impacts, and Vulnerability*: Indicators and Impacts, Southeast United States: This report served as the primary basis for the Regional Climate Trends and Scenarios for the NCA. The report provides climate change projections for temperature, precipitation, extreme heat, and SLR for the southeast U.S. and the Caribbean using 15 coupled atmosphere-ocean general circulation models. These models were downscaled to a resolution of approximately190 miles latitude and 60 to110 miles longitude for multi-model mean maps (*Ingram et al. 2013*).

Further information on the models used in this Final Programmatic Environmental Impact Statement can be found in Appendix F, *Climate Change Sources and Models*.

There is limited recent information available on the future projection of temperature and precipitation for the Caribbean, including in the NCA. *Centella et al. (2008)* provides regional temperature and precipitation projections for the Caribbean. This study was published through a joint effort involving the Cuban Institute of Meteorology and the Caribbean Community Climate Change Centre. The study uses the PRECIS (Providing Regional Climates for Impact Studies) model, which provides regional downscaled models at 25-kilometer or 50-kilometer resolution

[1] Radiative forcing is the difference between the radiation absorbed by Earth and the energy reflected back to space.

for the Caribbean. Although this study provides regional projections, there is variability in the trends of precipitation of the data presented by *Centella et al. (2008)* compared to more recently published global data. Climate change projections are improved by using recent data, models, and with increased technology. Therefore, more recent studies and models are better to use and more relevant. Therefore, for the Caribbean, the NCA summary provides more recent and relevant data to the region.

The projections prepared and presented in the NCA are the most recent and relevant to the U.S. and its territories. Since the Proposed Action has an undetermined timeline, outputs have been provided through to the end of the 21st century. The NCA provides climate projections using A2 (high emissions) and B1 (low emission) scenarios, which cover a significant range of potential future human impacts on the climate system. Additionally, many available literature sources use these two scenarios to evaluate potential impacts as well as mitigation and adaptation measures. This analysis evaluates climate projections using the A2 and B1 emissions scenarios, which are presented in the NCA.

8.2.14.4. Global and Regional Climate Change Projections

Temperature and Precipitation

Mean annual temperature is projected to increase between 2 degrees Fahrenheit (°F) and 4°F across the Caribbean compared to the late 20th century average (*Ingram et al. 2013*). Models show increasing number of warm nighttime temperatures across the Caribbean (*Ingram et al. 2013*). Precipitation will continue to decrease throughout the end of the century in the Caribbean in all Intergovernmental Panel on Climate Change (IPCC) models (*Ingram et al. 2013*). Decreasing precipitation is more pronounced in the summer and winter months (*Ingram et al. 2013*). Hurricane frequency is projected to decrease in the Caribbean due to increased vertical wind shear (*Ingram et al. 2013*). Vertical wind shear, which is a measure of change of winds with height, is a factor in determining storm severity. However, it is important to note that no definitive correlations have been established between GHG emission and hurricane activity.

Global Sea Level Rise

Global sea level is expected to rise throughout the century. The National Oceanic and Atmospheric Administration's report on global sea level scenarios supporting the NCA concludes with high confidence (greater than 9 in 10 chance) that the global mean sea level will rise at least 8 inches and up to 6.6 feet by 2100 (*Parris et al. 2012*). SLR is primarily attributed to ocean thermal expansion and ice sheet loss. However, recent studies by The National Research Council based on satellite measurements indicate that the ice sheet loss has greater contribution to global SLR than thermal expansion in the period from 1993 to 2008 (*Parris et al. 2012*). Global SLR projections use four scenarios:

- Highest, which should be considered for situations with little tolerance for risk;
- Intermediate high, which is based on an average of the high-end global SLR projections;

- Intermediate low, which is based on the upper global SLR projections using B1 emissions scenarios from IPCC's Fourth Assessment Report; and
- Lowest, which is based on linear extrapolation of historical SLR from tide gauge records since 1900. This scenario should be considered where there is great tolerance for risk (*Parris et al. 2012*).

Table 8.2.14-2 below illustrates projected global SLR using the four scenarios relative to mean sea level in 1992.

Table 8.2.14-2: Projected Global Sea Level Rise Relative to 1992

Scenario	Sea Level Rise (SLR) by 2100 (feet)[a]
Highest	6.6
Intermediate high	3.9
Intermediate low	1.6
Lowest	0.7

Source: Parris et al. 2012

[a] Relative to mean sea level in 1992

8.2.14.5. Description of Environmental Concerns

Greenhouse Gas Emissions

Since the industrial revolution, increasing GHG emissions from human activities (referred to as anthropogenic emissions and contrasting with emissions arising from natural processes) have increased the levels of GHGs in the atmosphere. Anthropogenic emissions enhance the greenhouse gas effect and result in a greater amount of heat that is trapped in the atmosphere (*IPCC 2013*). Human activities that cause GHG emissions include the combustion of fossil fuel, industrial processes, land use changes, deforestation, and agricultural production. Together, these GHG emissions contribute to climate change globally. There is no causal connection between GHG emissions arising from the deployment of the Proposed Action and the potential local impacts from global climate change.

Climate Change

Climate changes due to increasing global GHG emissions are projected to produce a range of effects, including changes in temperature, precipitation, and sea level as well as changes in frequency and intensity of weather events when compared to historical trends. These climate change effects could exacerbate the potential impacts on environmental resources from operations associated with the Proposed Action.

Climate change projections have been presented for the A2 (high emissions) and B1 (low emissions) scenarios. However, this analysis took a precautionary approach by using and discussing the worst case scenario (high emission A2) to ensure future potential impacts and outcomes are not underestimated. Climate models and projections apply to the entire Caribbean including Puerto Rico. In anA2 scenario, temperature in the Caribbean is expected to increase by 6.1°F by the end of the century (*Centella et al. 2008*). Precipitation is projected to decrease in the Caribbean through the end of the century (*Ingram et al. 2013*). Furthermore, drought frequency is expected to increase (*Ingram et al. 2013).*

As a result of these changes, damage to infrastructure could occur from storm surges or sea-level rise. This could lead to increased costs for replacement of infrastructure, particularly in coastal areas (*Ingram et al. 2012*). Rising sea levels would increase the likelihood of coastal flooding, erosion, and salt water intrusion, leading to degradation of aquifers and natural ecosystems (*Ingram et al. 2012*). Sea-level rise would increase vulnerability to coastal structures and properties; however, potential impacts would vary with location depending on regional sea level variability coupled with an increasing global average sea level. Increases in extreme heat events can lead to softened asphalt and ruptured concrete impacting various infrastructure and transportation networks (*Ingram et al. 2013*). Additionally, increase in drought frequency in the Caribbean could further impact water availability in the future.

Climate change from temperature, precipitation, and extreme weather events could have potential impacts on human health by increasing incidences of various infectious diseases particularly related to water quality (*Ingram et al. 2013*).

An increase in temperature could increase stress in vegetation and wildlife species potentially impacted by the Proposed Action. Additionally, drier conditions could increase soil contraction, impacting foundations of infrastructure (*Ingram et al. 2013*). Changes in precipitation and increases in extreme weather events could potentially exacerbate impacts due to soil erosion and top soil mixing. Foundations for infrastructure and infrastructure near coastal areas could be particularly vulnerable to increased soil erosion. Furthermore, changes in temperature and precipitation and increases in extreme weather could increase stress on wetlands and biodiversity.

8.2.14.6. Potential Impacts of the Preferred Alternative

Given this environmental impact statement is programmatic and does not include any site-specific locations or deployment technology, it is impossible to determine the actual GHG emissions associated with any of the action alternatives. This information could only be captured once the site-specific information is determined, such as site conditions, the type of deployment, and any permits or permissions necessary to perform the work. However, an assessment of potential impacts is provided in this section based on the potential emissions associated with the various activities that could occur as a result of the implementation of the Preferred Alternative, including deployment and operational activities.

Potential climate change impacts associated with the Preferred Alternative include potential impacts from the Preferred Alternative on climate change, in terms of an increase in GHG emissions, as well as the opposite: climate change effects on the Preferred Alternative.

GHG emissions would arise from combustion of fossil fuel in stationary or mobile equipment, clearing of vegetation, use of generators, and changes in land use during construction and operation. The types of stationary and mobile equipment that could be used include excavators, backhoes, frontend loaders, graders, pavers, and dump trucks. Additionally, combustion of fuel used in power generators, first responder on-road vehicles, and aerial platforms such as drones and piloted aircraft would contribute to GHG emissions. GHGs are characterized in terms of their global warming potential (GWP). The GWP is a measure of how much energy the emission of 1 tonne[2] of gas will absorb over a period of time, relative to the emission of 1 tonne of carbon dioxide (CO_2). This metric is normalized in terms of carbon dioxide equivalents (CO_2e) and expressed with a time horizon. The most commonly used time horizon is 100 years, where 1 unit of CO_2 will have a 100-year GWP of 1; an equivalent amount of methane will have a 100-year GWP of 25, and an equivalent amount of nitrous oxide will have a 100-year GWP of 298. GHG emissions would be emitted locally but have a global effect as explained in Section 8.1.14.2, Context. The GWP values are revised from time to time and should be updated accordingly based on the IPCC Assessment Reports. Current values derive from the Fourth Assessment Report (*IPCC 2007*).

GHG emissions arise from combustion of fossil fuel in stationary or mobile equipment, use of generators, clearing of vegetation, and changes in land use during construction and operation. GHG emissions from loss of vegetation and soil disturbance are expected to be minimal and therefore will not be estimated in this analysis.[3] GHG emissions from various potential sources that could be associated with the deployment and operation of the Preferred Alternative are presented in this section.

Potential Deployment Impacts

As described in Section 2.1.2, Proposed Action Infrastructure, implementation of the Preferred Alternative could result in the deployment of various types of facilities or infrastructure. Depending on the facility infrastructure and specific deployment requirements, climate change effects could result in potential impacts from some activities associated with the Preferred Alternative in terms of GHG emissions. Such GHG emission s from deployment of the Preferred Alternative could range from *less than significant* to *no impacts* at the programmatic level depending on the project types deployed. Further assessment of GHG emissions could be performed once site-specific details become available, such as site conditions, the type of deployment, and any permits or permissions necessary to perform the work.

In addition to potential effects from the Preferred Alternative on climate change, potential climate change effects on the Preferred Alternative were assessed. If deployment activities occur in the next 10 years, as is anticipated, climate conditions in that period would not differ much from current conditions even in the worst case emission scenario. Therefore, climate change effects on the various deployment activities would likely be minimal and are expected to have *no impact* at the programmatic level.

[2] One tonne is a unit of measure in the International System of Units that is equivalent to 1 metric ton and equivalent to 1.1023 U.S. tons, which are also known as short tons.
[3] Emissions from vegetation loss are not significant in the evaluation of the Preferred Alternative. The greatest source of GHG emissions would likely come from loss of forest.

Activities Likely to Have No Impacts

Of the types of facilities or infrastructure development scenarios described in Section 2.1.2, Proposed Action Infrastructure, climate change effects are likely to have *no impact* at the programmatic level to the following facilities under the conditions described below:

- Satellites and Other Technologies
  - Satellite-Enabled Devices and Equipment: These projects would include installing permanent equipment on existing structures. GHG emissions would arise from fuel combustion from delivery and installation of equipment; however, the use of satellite-enabled devices and equipment would not create any perceptible changes in GHG emissions.
  - Deployment of Satellites: FirstNet does not anticipate launching satellites as part of the nationwide public safety broadband network (NPSBN); however, it could include equipment on satellites that are already being launched for other purposes. Therefore it is anticipated that there would be no GHG emissions or any climate change effects on the project because of these activities. Any greenhouse gas analysis would likely be performed to the extent necessary by the agency authorizing or launching the satellite.

Activities with the Potential to Have Impacts

Potential climate change impacts associated with deployment activities as a result of implementation of the Preferred Alternative include increased GHG emissions. GHG emissions would arise from the combustion of fuel used by equipment during construction and changes in land use. Land use emissions could occur as a result of soil disturbance and loss of vegetation. GHG emissions from loss of vegetation and soil disturbance are expected to be minimal and therefore are not estimated. The types of deployment activities that would create GHG emissions are discussed below.

<u>Wired Projects</u>

GHG emissions would arise from combustion of fuel from the equipment used for plowing, trenching (including vibratory plowing), or directional boring during construction for buried wired projects. The worst-case emissions are expected to result from plowing techniques. For aerial wired projects, construction activities could include new wiring and poles that require use of auger trucks, boom truck, and bucket lifts, as well as excavation and grading equipment that use fossil fuels. Other activities associated with installation of new or modification of existing wired systems and associated infrastructure, including points of presence[4] (POPs) and huts, could result in GHG emissions during cable blowing, pulling, and vault placement. For some deployment activities, new structures could be required without the need for new or modified wired systems. GHG emissions from fuel combustion due to construction of deployment of wired projects have been estimated and are presented in Tables 8.2.14-3 and 8.2.14-4. Emission calculations assume that all construction equipment use diesel fuel and would have the same

[4] Points of presence are connections or access points between two different networks, or different components of one network.

emissions. Therefore, each table shows a summation of the estimated emissions for the construction equipment required for each deployment activity. Emission calculations are also based on the assumption of 3 months of site-specific deployment length as a conservative estimate (although in many cases the deployment period will be considerably shorter, potentially as little as a few hours).

Table 8.2.14-3: GHG Emission Estimates from Buried Wired Project Deployment[a]

Emission Source[b,c]	Estimated Emissions[d,e,f]	
	CO_2e (tons/year)	CO_2e (metric tons/year)
Vibratory Plow, Backhoe, Dozer, Flat-bed Truck, Pick-up Truck, Trench Roller, Air Compressor, Cable Blower, Concrete Mixer, Grader, Roller	1,403	1,273

CO_2e = carbon dioxide equivalent

[a] Deployment activities are assumed to include excavation, grading, and pole delivery and installation.
[b] Emissions are based on one unit of typical equipment. One unit consists of one each of the equipment listed in the table, operating simultaneously. If additional equipment is required, equipment-specific emission estimates should be multiplied by the number of equipment units.
[c] Each equipment is assumed to have a maximum rated capacity of 300 horsepower and to be 10 years old (equipment age). If new equipment is used, emissions would be lower.
[d] Emissions are estimated using methodology from *USEPA 2010a*. Typical equation values were obtained from *USEPA 2010b*.
[e] Emissions (tons) assume 240 hours (24 days, 10 hours/day) of construction activity per month. Construction was assumed to last for 3 months in a year. If construction lasts for more than 3 months, emissions would be greater than the values listed here.
[f] Fuel is assumed to be ultra-low sulfur diesel.

Table 8.2.14-4: GHG Emission Estimates from New Aerial Wired Project Deployment[a]

Emission Source[b,c]	Estimated Emissions[c,d,e,f]	
	CO_2e (tons/year)	CO_2e (metric tons/year)
Grader, Suction Excavator, Auger Truck, Boom Truck, Cable Blower, Bucket Lift, Flat-bed Truck	893	810

CO2e = carbon dioxide equivalent

[a] Deployment activities are assumed to include excavation, grading, and pole delivery and installation.
[b] Emissions are based on one unit of typical equipment. One unit consists of one each of the equipment listed in the table, operating simultaneously. If additional equipment is required, equipment-specific emission estimates should be multiplied by the number of equipment units.
[c] Each equipment is assumed to have a maximum rated capacity of 300 horsepower and to be 10 years old (equipment age). If new equipment is used, emissions would be lower.
[d] Emissions are estimated using methodology from *USEPA 2010a*. Typical equation values were obtained from *USEPA 2010b*.
[e] Emissions (tons) assume 240 hours (24 days, 10 hours/day) of construction activity per month. Construction was assumed to last for 3 months in a year. If construction lasts for more than 3 months, emissions would be greater than the values listed here.
[f] Fuel is assumed to be ultra-low sulfur diesel.

Potential GHG impacts associated with each type of wired project are discussed below:

- Use of Existing Conduit – New Buried Fiber Optic Plant: Existing conduits would be used in the installation of new fiber optic cable, which could require construction equipment for cable blowing or pulling. The emissions associated with the use of existing conduit would arise from use of similar equipment as those listed in Table 8.2.14-4. The short duration and intermittent use of heavy equipment would not produce perceptible changes to climate change.

- Use of Existing Buried or Aerial Fiber Optic Plant or Existing Submarine Cable: These projects involve lighting up dark fiber and installation of new equipment in existing huts. The use of heavy construction equipment is not expected, and movement of equipment by light truck or cars would produce a minimal amount of GHGs in the context of this Preferred Alternative. Therefore, no significant GHG emissions are expected to arise from these activities. As mentioned above, GHG emissions from ground disturbance and vegetation loss are expected to be minimal.
- New Build –Buried Fiber Optic Plant: This activity would include plowing (including vibratory plowing), trenching, and directional boring, and could involve construction of POPs, huts, or other facilities to house outside plant equipment or hand holes to access fiber. The emissions associated with fuel use from these activities are estimated in Table 8.2.14-3. These annual CO_2e emissions resulting from deployment of buried fiber for one unit of equipment, operating for a total of 3 months within a given year, are equivalent to 1,403 tons (1,273 metric tons).
- New Build – Aerial Fiber Optic Plant: These projects would require construction equipment for installing or replacing new poles and hanging cables as well as excavation and grading for new or modified right-of-ways or easements. It could also include construction of POPs, huts, or other facilities to house outside plant equipment. The GHG emissions from burning fuel for one unit of equipment, operating for a total of 3 months within a given year are estimated in Table 8.2.14-4. The total emissions are estimated at 893 tons (810 metric tons) per year.
- Collocation on Existing Aerial Fiber Optic Plant: These projects would require equipment for replacement of existing wiring and poles. GHG emissions associated with these projects would arise from use of less equipment than those listed in Table 8.2.14-4. As a result, these emissions have not been estimated separately but are expected to be fewer than the total emissions from New Build – Aerial Fiber Optic Plant projects, analyzed above.
- New Build – Submarine Fiber Optic Plant: The need for deploying large marine vessels for laying deep underwater cables is unlikely. However, small work boats (with engines similar to recreational vehicle engines) may be required to transport and lay small wired cable. The emissions from these small marine sources would be negligible.
- Installation of Optical Transmission or Centralized Transmission Equipment: The construction of small boxes or huts or other structures would require construction equipment and additional cranes or sky lifts for installation. GHG emissions for one unit of equipment, operating for a total of 3 months within a given year, correspond to those emissions from Table 8.2.14-5. These emissions are estimated at 766 tons (695 metric tons).

Table 8.2.14-5: GHG Emissions Estimates from Tower, Structure, and Transmission Equipment Delivery and Installation[a]

Emission Source[b,c]	Estimated Emissions[c,d,e]	
	CO_2e (tons/year)	CO_2e (metric tons/year)
Concrete Mixer, Flat-bed Truck, Grader, Paver, Roller, Truck-mounted Crane	766	695

CO_2e = carbon dioxide equivalent

[a] Emissions are based on one unit of typical equipment. One unit consists of one each of the equipment listed in the table, operating simultaneously. If additional equipment is required, equipment-specific emission estimates should be multiplied by the number of equipment units.
[b] Equipment is assumed to have a maximum rated capacity of 300 horsepower and to be 10 years old (equipment age). If new equipment is used, emissions would be lower.
[c] Emissions are estimated using methodology from *USEPA 2010a*. Typical equation values were obtained from *USEPA 2010b*.
[d] Emissions (tons) assume 240 hours (24 days, 10 hours/day) of construction activity per month. Construction was assumed to last for 3 months in a year. If construction lasts for more than 3 months, emissions would be greater than the values listed here.
[e] Fuel is assumed to be ultra-low sulfur diesel.

Wireless Projects

Emissions associated with installation of structures for wireless projects are similar to those found in Table 8.2.14-5 above. GHG emissions associated with each type of wireless project are discussed below:

- New Wireless Communication Towers: These projects would involve installation of new towers as well as associated structures including generators, equipment sheds, fencing, security lighting, aviation lights, and electrical feeds. Emissions from installation of new towers are estimated in Table 8.2.14-5. The annual emissions from these tower structure delivery and installation projects, assuming one unit of equipment operating for a total of 3 months within a given year, are estimated at 766 (695 metric tons) per year.
- Collocation on Existing Wireless Tower, Structure, or Building: Collocation would require mounting and installation of equipment on an existing tower. GHG emissions could arise from combustion of fuel from trucks required for the delivery and installation of equipment and from the equipment used for excavation and grading. GHG emissions for these projects are expected to be fewer than the total emissions associated with New Wireless Communication Towers projects (which are estimated in Table 8.2.14-5) because there would be no new towers built.

Deployable Technologies

GHG emissions would arise from use of Deployable Technologies from combustion of fuel from on-road vehicles and mobile power generators. It is assumed that diesel generators are the most likely fuel technology although gasoline and hydrogen-fueled generators could be an option. On-road vehicles could include light-duty trucks for Cell on Light Truck projects or heavy-duty trucks for Cell on Wheels and System on Wheels. Emissions from diesel-power generators are estimated in Table 8.2.14-6.

Table 8.2.14-6: GHG Emissions Estimates from Heavy and Light Duty Vehicles[a]

Vehicle Type	Emission Factors[b,c]			Emissions	
	CO_2	CH_4	N_2O	Ton CO_2e/year	Metric tons CO_2e/year
	kg/gal	g/mi	g/mi		
Light Truck	10.21	0.0009	0.0014	1.80	1.63
Heavy Duty Vehicles	10.21	0.0051	0.0048	1.80	1.63

CO_2 = carbon dioxide; CH_4 = methane; N_2O = nitrous oxide; CO_2e = carbon dioxide equivalent; kg/gal = kilograms per gallon; g/mi = grams per mile

[a] Emissions are estimated assuming one vehicle operates 8 hours per day, 2 days per year (one day for driving to location, one day for departing from location). Driving emissions are larger than idling emissions; therefore, all operation was assumed to be driving, with an average speed of 50 miles per hour.
[b] Emission factors taken from *Climate Registry (2015)*, Default Emission Factors 2014 Table 13.1 and 13.4.
[c] Fuel efficiency for light and heavy trucks taken from *Understanding Tractor-Trailer Performance* (*Caterpillar 2006*).

GHG emissions associated with each type of deployable technology are discussed below:

- Cell on Wheels: These projects consist of a cellular base station on a trailer, which is a heavy-duty vehicle. The generators would power the cell unit while the vehicle is on-site and stationary and the vehicle engines would power the vehicle when it is traveling to and from the site. The GHG emissions from the use of heavy-duty vehicles are presented in Table 8.2.14-6. This estimation assumed that one vehicle operates for 2 days a year twice a year, traveling to and from the site for deployment (operating emissions are calculated separately, below).
- Cell on Light Truck: GHG emissions would arise from the combustion of fuel from light-duty truck and diesel generator for powering the cellular base station. Similar to Cell on Wheels, the generators would power the cell unit while the vehicle is onsite and stationary; however, the vehicle engines would power the vehicle while traveling to the site. The GHG emissions from use of a light-duty truck are presented in Table 8.2.14-6. This estimation assumed that one vehicle operates for 2 days a year twice a year, traveling to and from the site for deployment (operating emissions are calculated separately, below).
- System on Wheels: These projects include a full base station and controller on a large towable trailer or truck. These trailer or trucks are similar to the heavy duty vehicle and diesel-power generator associated with the Cell on Wheels technology. As such, GHG emissions from these projects are expected to be similar to those for Cell on Wheels and are listed in Table 8.2.14-6. This estimation assumed that one vehicle operates for 2 days a year twice a year, again for deployment only.
- Deployable Aerial Communication Architecture: These projects consist of deploying aerial vehicles such as drones, balloons, blimps, and piloted aircraft to staging areas. (Operating these vehicles is discussed separately under Potential Operation Impacts, below). GHG emissions would arise from fuel combustion from this staging activity. These emissions have not been estimated but would likely be less than those used in installation and delivery of tower, structure, and transmission equipment (which are estimated in Table 8.2.14-5).

GHG Emissions during Deployment

It is likely that the Preferred Alternative would use one or more or a combination of the above mentioned activities. Given this environmental impact statement is programmatic and does not include any site-specific locations or deployment technology, it is impossible to determine the actual GHG emissions associated with deployment activities. This information could only be captured once the site-specific information is determined, including the number of each of the emissions sources that would be implemented. However, although specific sites are geographically widespread across the non-contiguous region, any one site would be limited in extent and the quantity of GHG emissions would be relatively minor, as explained in the analysis. There is no information to indicate that GHG emissions would be significant relative to other alternative scenarios.[5] As such, the potential impact of the Preferred Alternative on climate change is considered to be *less than significant* at the programmatic level. In addition, BMPs and mitigation measures presented in Chapter 11, BMPs and Mitigation Measures, could help reduce potential GHG impacts. For example, FirstNet and its partners could use vehicles with hybrid or electric technology, as practicable or feasible, to reduce or eliminate emissions from fuel combustion.

Potential Operation Impacts

GHG Emissions

As described in Section 2.1.2, Proposed Action Infrastructure, operation activities associated with the Preferred Alternative would consist of routine maintenance and inspection of the facilities. Any major infrastructure replacement as part of ongoing system maintenance would result in similar potential impacts to the abovementioned potential deployment impacts. There would be GHG emissions from combustion of trucks and other equipment used for routine inspection of the Preferred Alternative. However, these emissions would be far fewer than those associated with deployment activities. It is anticipated that there would be no GHG emissions associated with soil disturbance and vegetation loss from routine inspections of the Preferred Alternative, assuming that the same access roads used for deployment are used for inspection.

Operational activities associated with the Preferred Alternative could involve operation of fossil fuel power generators in Wireless Projects and Deployable Technologies. This analysis assumed that these power generators would use diesel fuel; however, other fuels, such as gasoline, propane, and hydrogen could also be options. Power generators would be used as backup generators and operated while onsite for wireless projects during upset conditions where commercial power is interrupted and during routine maintenance; as a result, they would be expected to operate for only a short period of time. For deployable technologies, power generators would be utilized as the primary power source. The deployable technologies would

[5] According to the Council of Environmental Quality Final Guidance, "When considering GHG emissions and their significance, agencies should use appropriate tools and methodologies for quantifying GHG emissions and comparing GHG quantities across alternative scenarios...The rule of reason and the concept of proportionality caution against providing an in-depth analysis of emissions regardless of the insignificance of the quantity of GHG emissions that would be caused by the proposed agency action." (*CEQ 2016*)

operate on site for as long as needed. The types of deployment activities that GHG emissions would arise from include the following:

- Wireless Projects
  - New Wireless Communication Towers: GHG emissions would arise from use of power generators including those that operate by combustion of fossil fuels. Backup power generators would only operate for a short period of time during upset conditions when commercial power supply has been interrupted or during routine maintenance. This analysis assumed a maximum of 500 hours per year for both upset conditions and routine maintenance. These emissions have been estimated and are presented in Table 8.2.14-7 below. The annual emissions for backup power generators are 19.3 tons (17.5 metric tons) of CO_2e for one unit.
  - Collocation on Existing Wireless Tower, Structure or Building: These projects could involve the use of backup power generators such as diesel-power generators. The emissions from combustion of fuel for power generators are comparable to New Wireless Communication towers and are presented in Table 8.2.14-7 below.

Table 8.2.14-7: GHG Emissions from Back-up Diesel Power Generators for Wireless Projects

Emission Source	Estimated Emissions[a,b]	
	CO_2e (tons/year)	CO_2e (metric tons/year)
Diesel Generators	19.3	17.5

CO_2e = carbon dioxide equivalent

[a] Emission factors taken from *AP-42, Compilation of Air Pollutant Emission Factors*, Section 3.3, Gasoline and Diesel Industrial Engines, Table 3.3-1 (diesel engines) (*USEPA 1996*).
[b] Emissions are estimated assuming one, 67-horsepower diesel engine operates for 500 hours per year when commercial power is interrupted and during normal routine maintenance. Estimates can be directly scaled based on actual equipment size and operating schedule.

- Deployable Technologies
  - Operation of land-based deployable technologies would involve use of power generators such as diesel-power generators to power the cell unit. This analysis assumed power generators operating continuously for 24 hours a day and for 363 days a year (deployment to and from the site would require 2 additional days, as discussed above). The emissions from combustion of fuel for power generators are presented in Table 8.2.14-8 below. The annual emissions for power generators for deployable technologies are 160 tons (145 metric tons) of CO_2e for one unit. These projects may also consist of deploying aerial vehicles including, but not limited to, drones, balloons, blimps, and piloted aircraft, which could involve fossil fuel combustion. These emissions would not be similar to any of the other technologies presented here. More information would be required regarding the number, type, and flight duration of the vehicles deployed to determine emissions from these technologies. There would be no GHG emissions associated with operation of balloons.

Table 8.2.14-8: GHG Emissions from Power Generators for Deployable Technologies

Emission Source	Estimated Emissions[a,b]	
	CO_2e (tons/year)	CO_2e (metric tons/year)
Diesel Generators	160	145

CO_2e = carbon dioxide equivalent

[a] Emission factors taken from AP-42, *Compilation of Air Pollutant Emission Factors*, Section 3.3, Gasoline and Diesel Industrial Engines, Table 3.3-1 (diesel engines) (*USEPA 1996*).
[b] Emissions are estimated assuming one, 32-horsepower diesel engine operates continuously (24 hours per day), 363 days per year (all year except for two travel days – see Tables 8.2.14-6 and 8.2.14-7). Estimates can be directly scaled based on actual equipment size and operating schedule.

Given this environmental impact statement is programmatic and does not include any site-specific locations or deployment technology, it is impossible to determine the actual GHG emissions associated with operation activities. This information could only be captured once the site-specific information is determined, including the number of each of the emissions sources that would be implemented. However, as with deployment impacts, any one site would be limited in extent and the quantity of GHG emissions from operations would be relatively minor, as explained in the analysis. There is no information to indicate that GHG emissions would be significant relative to other alternative scenarios. As such, the potential impact of the Preferred Alternative on climate change is considered to be *less than significant* at the programmatic level. In addition, Chapter 11, BMPs and Mitigation Measures, lists BMPs and mitigation measures that FirstNet and/or their partners would require, as practicable or feasible, to help avoid or minimize potential impacts associated with GHG emissions. For example, FirstNet and its partners could use vehicles with hybrid or electric technology, as practicable or feasible, to reduce or eliminate emissions from fuel combustion.

Potential Climate Change Impacts on the Preferred Alternative

Climate change effects such as changes in temperature, precipitation, and sea-level rise during operations could potentially impact the infrastructure of the Preferred Alternative. Section 8.1.14.4, Global and Regional Climate Change Projections, presents climate change effects projected for Puerto Rico through the end of the 21st century. The potential impacts on the Preferred Alternative from climate change effects include the following:

- Projections indicate increasing average annual temperatures through the end of the century. These increases could lead to potential impacts associated with heat stress and wildfire risk, potentially affecting aboveground infrastructure. This would include towers, antennas, POPs, huts, poles, and microwave dishes.
- Precipitation is expected to decrease in the Caribbean. Potential impacts could include higher evapotranspiration rates, leading to heat stress and wildfire risks. These effects could potentially impact aboveground infrastructure such as towers, antennas, POPs, huts, poles, and microwave dishes.
- Projections indicate that the global mean sea level would rise through the end of the century. Sea level rise increases the likelihood for coastal flooding and erosion. Sea level rise, soil and coastal erosion, and flooding could pose potential significant impacts to infrastructure near or on the coast such as huts for buried aerial fiber optic or submarine fiber optic.

Additionally, other aboveground infrastructure such as antennas, POPs, and poles could potentially be impacted during extreme events.

Adaptation to Climate Change Effects during Operation

Based on the analysis of the operational activities described above, climate change effects on the Preferred Alternative could be *potentially significant* to *less than significant with BMPs and mitigation measures incorporated* at the programmatic level because climate change effects such as changes in temperature, precipitation, and sea-level rise during operations could potentially impact the infrastructure of the Preferred Alternative. Mitigation measures or BMPs could minimize or reduce the severity or magnitude of potential impacts to the Preferred Alternative, while adaptation refers to anticipating adverse effects of climate change and taking appropriate action to prevent and minimize the damage climate change effects could cause. See Chapter 11, BMPs and Mitigation Measures, for a listing of BMPs and mitigation measures that FirstNet and/or their partners would require, as practicable or feasible, to help minimize climate change effects on the Preferred Alternative.

8.2.14.7. Alternatives Impact Assessment

The following section assesses potential impacts of climate change on the Deployable Technologies Alternative and the No Action Alternative.[6]

Deployable Technologies Alternative

Under the Deployable Technologies Alternative, a nationwide fleet of mobile communications systems would provide temporary coverage in areas not covered by the existing, usable infrastructure. There would be no collocation of equipment and no new construction associated with wired or wireless projects as discussed above under the Preferred Alternative. The specific infrastructure associated with the Deployable Technologies Alternative would be the same as the deployable technologies implemented as part of the Preferred Alternative but would likely be implemented in greater numbers, over a larger geographic extent, and used with greater frequency and duration. Potential impacts of climate change on the implementation of this alternative are described below. As with the Preferred Alternative, the effects of this alternative on climate change (in terms of GHG emissions) were examined both in terms of the potential impact the Deployable Technologies Alternative might have on climate change (primarily from GHG emissions) and the potential impact climate change might have on the Deployable Technologies Alternative (primarily potential damage to the deployable architecture itself).

Potential Deployment Impacts

The potential impacts on climate change from this alternative were assessed in terms of its potential to generate GHG emissions. As explained above, implementation of deployable technologies would involve use of fossil-fuel-powered vehicles, powered generators, and/or aerial platforms. There would be some emissions and potentially soil and vegetation loss as a

[6] As mentioned above and in Section 2.1.2, Proposed Action Infrastructure, the Preferred Alternative includes implementation of deployable technologies.

result of excavation and grading for staging and/or landing areas depending on the type of technology. In addition, GHG emissions would arise from fuel combustion from staging of aerial vehicles. These emissions have not been estimated; more information would be required regarding the number, type, and staging locations of the vehicles deployed to determine actual emissions from these technologies. However, as with the Preferred Alternative, any one site would be limited in extent and the quantity of GHG emissions would be relatively minor, as explained in the analysis. There is no information to indicate that GHG emissions would be significant relative to other alternative scenarios. As such, the potential impact on climate change is considered to be *less than significant* at the programmatic level for deployment of the Deployable Technologies Alternative.

In addition to potential impacts on climate change from this alternative, the potential impacts from climate change on this alternative were assessed. Climate change effects on this alternative during deployment would be similar to such effects on the Preferred Alternative. If deployment activities occur in the next 10 years, as is anticipated, climate conditions in that period would not differ much from current conditions even in the worst case emission scenario. Therefore, climate change effects on the various deployment activities would likely have little to *no impact* at the programmatic level. See the section below for more discussion on potential climate change effects during operation.

Potential Operation Impacts

As explained above, operation activities would consist of implementation/running of the deployable technology and routine maintenance and inspections. As with the Preferred Alternative, it is anticipated that there would be few GHG emissions associated with routine inspections of the Deployable Technologies Alternative, assuming that the same access roads used for deployment are also used for inspections. Emissions would arise from use of power generators as the main power source. Emissions from the use of one fossil-fuel-powered generator would not be significant; for example, the annual emissions for power generators for deployable technologies are 160 tons (145 metric tons) of CO_2e for one unit. These potential impacts could be reduced through implementation of BMP and mitigation measures. These projects may also consist of deploying aerial vehicles including, but not limited to, drones, balloons, blimps, and piloted aircraft; all but balloons could involve fossil fuel combustion. These emissions would not be similar to any of the other technologies presented here. More information would be required regarding the number, type, and flight duration of the vehicles deployed to determine emissions from these technologies. As with the Preferred Alternative, the potential impact on climate change is considered to be *less than significant* at the programmatic level for operation of the Deployable Technologies Alternative.

Climate change effects on this alternative would have to most noticeable impacts over a long period of time. Climate change effects such as temperature, precipitation changes, and extreme weather during operations would be expected but could have little to *no impact* at the programmatic level on the deployed technology if the technologies are deployed within a short period of time (less than a decade). If there are no permanent structures, particularly near coastal areas, there would be little to *no impacts* as a result of sea-level rise. However, if these technologies are deployed continuously (at the required location) for a time period greater than a decade, climate change effects on infrastructure could be similar to the Preferred Alternative, as explained above. As a BMP, the locations of deployable infrastructure could be adjusted to allow for extreme weather events and flooding.

No Action Alternative

Under the No Action Alternative, the NPSBN would not be deployed; therefore there would be no associated construction or installation of wired, wireless, deployable infrastructure or satellites and other technologies. As a result, there would be no GHG impacts from the No Action Alternative. However, GHG emissions would be emitted from the current technologies used in Puerto Rico for first responders. Climate change effects such as changes in temperature and precipitation, extreme weather and sea-level rise would still occur globally and regionally but have *no impact* in the No Action Alternative since there would be no associated infrastructure.

8.2.15. Human Health and Safety

8.2.15.1. Introduction

This section describes potential impacts to human health and safety in Puerto Rico associated with deployment and operation of the Proposed Action. Mitigation measures, as defined through permitting and/or consultation with the appropriate resource agency, would be implemented as part of deployment and operation of the Proposed Action to help avoid or reduce potential impacts to human health and safety. Implementation of best management practices (BMPs), as practicable or feasible, could further reduce the potential for impacts. Both mitigation measures and BMPs are discussed in Chapter 11, BMPs and Mitigation Measures.

8.2.15.2. Impact Assessment Methodology and Significance Criteria

The potential impacts of the Proposed Action on human health and safety were evaluated using the significance criteria presented in Table 8.2.15-1. As described in Section 8.2, Environmental Consequences, the categories of impacts are defined at the programmatic level as *potentially significant*, *less than significant with BMPs and mitigation measures incorporated*, *less than significant*, or *no impact*. Characteristics of each impact type, including magnitude or intensity, geographic extent, and duration or frequency, were used to determine the impact significance rating associated with each potential impact.

Given the nature of this programmatic evaluation, and because the Proposed Action could potentially cover a wide variety of actions that would take place in various geographic and social settings, the potential impacts to health and safety addressed in this section are presented as a range of possible impacts. Potential impacts to human health and safety are assessed for both the workers and/or the general public, where applicable.

Environmental Consequences assessments for traffic, noise, water quality, and air quality, all of which have the potential to influence community and worker health, are covered in this Programmatic Environmental Impact Statement (see Section 8.2.1, Infrastructure; Section 8.2.13, Noise and Vibrations; Section 8.2.4, Water Resources; and Section 8.2.12, Air Quality; respectively). Applicable information from those assessments is referenced in this section if the potential impacts to those resources could result in impacts to community and worker/or health.

Other areas that directly or indirectly relate to health and safety but are not included in this section given the discussion in the respective resource sections include: radio frequency emissions (see Section 2.4, Radio Frequency Emissions); access to health and emergency services (see Section 8.2.1, Infrastructure); environmental justice issues that could result in decreased health (see Section 8.2.10, Environmental Justice); community cohesion and sense of safety (see Section 8.2.9, Socioeconomics).

Table 8.2.15-1: Impact Significance Rating Criteria for Human Health and Safety

Type of Effect	Effect Characteristic	Impact Level: Potentially Significant	Impact Level: Less than Significant with BMPs and Mitigation Measures Incorporated	Impact Level: Less than Significant	Impact Level: No Impact
Decrease in human health and safety (resulting from potential exposure to hazardous materials [including emissions, spills, and potential exposures via disturbance of historical contaminated sites]; accidents and injuries; exposure to noise; unsafe working conditions, and other recognized workplace safety hazards; and transmission of infectious diseases)	Magnitude or Intensity	Exposure to concentrations of chemicals above regulatory limits, or USEPA chemical screening levels protective of the general public; a net increase in the amount of hazardous or toxic materials or wastes generated, handled, stored, used, or disposed of, resulting in unacceptable risk, exceedance of available waste disposal capacity, and probable regulatory violations; site contamination conditions could preclude development of sites for the proposed use; exposure to recognized workplace safety hazards; violations of various regulations including: OSHA, RCRA, CERCLA, TSCA, EPCRA	Effect that is *potentially significant*, but with BMPs and mitigation measures is *less than significant* at the programmatic level	No exposure to chemicals above health-protective screening levels; hazardous or toxic materials or wastes could be safely and adequately managed in accordance with all applicable regulations and policies, with limited exposures or risks; no exposure to unsafe working conditions or other workplace safety hazards	No exposure to chemicals, unsafe working conditions, or other workplace safety hazards
	Geographic Extent	Regional impacts observed ("regional" assumed to be at least a county or county-equivalent geographical extent, could extend to territory)		Impacts only at a local/neighborhood level	NA
	Duration or Frequency	Occasional frequency during the life of the Proposed Action		Rare event	NA

CERCLA = Comprehensive Environmental Response, Compensation, and Liability Act; EPCRA = Emergency Planning and Community Right-to-Know Act; NA = not applicable; OSHA = Occupational Safety and Health Administration; RCRA = Resource Conservation and Recovery Act; TSCA = Toxic Substances Control Act

8.2.15.3. Description of Environmental Concerns

Exposure to Hazardous Materials

Health effects from human exposure to contaminants can range from experiences of physical irritation/nuisance to acute illness to chronic disease outcomes, depending on the type of contaminant and level of exposure. The following are potential pathways for human exposure to contaminants in Puerto Rico associated with the Proposed Action.

Existing Contaminants in Soil or Water

The construction of the proposed facilities/infrastructure, trenching, and/or foundation excavation could expose soil containing contaminants from either existing industrial facilities or from legacy industrial activities. The disturbed soil could pose a health risk to workers and communities if there is direct contact with the soil or surface water runoff containing soil chemicals from the construction site. As outlined in the Affected Environment Health and Safety Section 8.1.15, Puerto Rico is a heavily industrialized area and has 33 active Superfund sites that have ongoing cleanup action around soil and ground water contamination, including volatile organic compounds such as benzene, tetrachloroethylene, and trichloroethylene (known carcinogens); Polycyclic aromatic hydrocarbon; and toxic heavy metals, including arsenic, chromium, lead, and mercury. Other existing sources of soil and water contamination that could potentially pose a risk to workers and communities include pesticides used primarily in agricultural areas on the islands, as well landfills that are not on the National Priorities List (*USEPA 2015; Marino 2014*). The implementation, as practicable or feasible, of water quality and soil erosion BMPs and mitigation measures (see Chapter 11, BMPs and Mitigation Measures) could help ensure that any contaminated soil and water are safely and adequately managed in accordance with all applicable regulations and policies, and exposure risks are minimized.

Potential Spills of Pollutants into Surface Water

Section 8.2.4.3, Description of Environmental Concerns, discusses the potential for water quality impacts that could occur from petroleum products accidentally spilled during refueling, or from potential pentachlorophenol associated with treated utility poles leaching into surface water, although concentrations of pentachlorophenol released during placement or replacement of poles are not expected to exceed United States (U.S.) Environmental Protection Agency levels of concern for human health (see Section 8.2.4.3, Description of Environmental Concerns). Health risks posed to workers and community members who could potentially come into contact with these chemicals range from acute to chronic illnesses, including increased risk of cancer (*USEPA 2000*).

In Puerto Rico, water used for human consumption is sourced from groundwater, however there are six rain-fed surface reservoirs used for public water supply. Some of the water from precipitation enters aquifers as ground-water recharge (*USGS 1995; 2009*). Therefore, surface water contamination could potentially impact catchment potable water systems. In the event of a larger spill that goes unnoticed, shallow groundwater wells used for potable water could also potentially be impacted. FirstNet will attempt, to the extent that is practicable or feasible, buildout/deployment locations in or adjacent to waterbodies or involve in-stream construction. The implementation of spill management BMPs and mitigation measures (see Chapter 11, BMPs and Mitigation Measures) could help to further ensure contaminated soil and water are safely and adequately managed in accordance with all applicable regulations and policies, and exposure risks are minimized.

Air Emissions from Mobile Sources

Section 8.2.12, Air Quality, discusses the potential impacts to air quality associated with the Proposed Action, which include emissions from stationary and mobile sources during deployment. Emissions could result from stationary or mobile equipment that burns fossil fuels, such as excavators or backhoes, that are required to support any clearance, drilling, and construction activities associated with network deployment. In addition, the use of power generators, first responder on-road vehicles (large towable trailers, commercial trucks, standard sport utility vehicles), and aerial platforms (aircraft such as drones and piloted aircraft) associated with the implementation of deployable technologies could also increase air emissions, both from fossil fuel combustion and, in some cases, from stirring up dust on unpaved roads. Emissions that may pose a health concern to both workers and communities are primarily particulate matter up to 2.5 micrometers in diameter ($PM_{2.5}$) and nitrogen dioxide (NO_2), both of which are produced by fossil fuel combustion associated with vehicle, heavy machinery, and generator use.

There is a substantial body of scientific literature linking both short-term and long-term adverse health impacts to various types of air pollution (*HEI 2010; Sarnat and Holguin 2007; Nishimura et al. 2013; Patel and Miller 2009; USEPA 2009; Levy et al. 2002*). NO_2 has been linked to short-term respiratory and cardiovascular effects (*USEPA 2008*). $PM_{2.5}$ has been linked to both short-term and long-term health effects. Specific health effects for $PM_{2.5}$ exposures include adverse cardiovascular effects, increase in cardiovascular and respiratory mortality, and adverse respiratory effects, including lung cancer (*USEPA 2009*).

Research to date has not revealed the existence of concentration thresholds for $PM_{2.5}$ and nitrogen oxides below which no health effects would be expected for sensitive populations.[1] Because a no-effect level has not been defined, the increase in emissions from deployment activities could potentially increase the risk of short-term and long-term effects to sensitive populations within the workforce or nearby communities (*HEI 2010; USEPA 2009 and 2013; Kelly and Fussell 2011; Levy et al. 2002; Nishimura et al. 2013; Patel and Miller 2009; O'Neill et al. 2005 and 2007; Sarnat and Holguin 2007*).

[1] If health-based air quality standards are being met, the health of the general population is unlikely to be adversely affected.

Sensitive populations for exposure to $PM_{2.5}$ and NO_2 are listed below:

- Those with chronic respiratory diseases (asthma and chronic obstructive pulmonary disease), particularly children and the elderly;
- Those with acute respiratory infections, particularly children and the elderly;
- Those with chronic heart diseases; and
- Those with diabetes.

With regards to sensitive populations in Puerto Rico, the prevalence of deaths from chronic lower respiratory disease and heart disease is lower than in the overall U.S.; however, adult asthma and diabetes prevalence and deaths from infectious respiratory diseases are higher than in the U.S. (*CDC 2013a, 2013b*). Overall, the percentage of the Puerto Rican population that could be considered sensitive is likely comparable to the national percentage.

It is important to note that there are multiple causes of the diseases associated with particulate exposures. Although it is possible that some cases of cardiovascular problems, respiratory problems, and lung cancer could be related to or result from or be worsened by $PM_{2.5}$; most cases of these health problems are associated with other causes, such as smoking.

According to Section 8.2.12, Air Quality, potential impacts to air quality associated with the Preferred Alternative activities could range from *no impacts* to *less than significant* at the programmatic level depending on the deployment or operation scenario, or the site-specific conditions. It is anticipated that any air pollution increase due to deployment would likely be short-term with pre-existing air quality levels generally achieved after some months or even less (typically less than a year). The implementation of appropriate air quality BMPs and mitigation measures (see Chapter 11, BMPs and Mitigation Measures) could further help to reduce human exposure to air contaminants and minimize the potential risk of health effects.

Accidents and Injuries

Workplace and Construction Site Accidents and Injuries

The Preferred Alternative construction activities, including excavation, drilling, buried, or aerial installations and transportation to and from work sites, could increase the risk of accidents and injuries to both workers and communities. For communities, inadequate safety signage at construction and other work sites, as well as poor public awareness regarding construction risks can increase the risk of injuries and accidents for community members living or working in proximity to those sites. For the workforce, workplace hazards such as work at heights and work involving the use of heavy machinery increase the risk of slips, trips, falls, and other accidents. The U.S. Occupational Safety and Health Administration (OSHA) maintains authority over all federal and private sector workplaces in Puerto Rico; therefore, although accidents and injuries are considered an employee workplace hazard, FirstNet and/or their partners would establish policies and procedures to help assure a safe and healthful workplace in compliance with OSHA standards.

Road Traffic Accidents and Injuries

In addition to worksite accidents and injuries, temporary traffic congestion on public roads as discussed in Section 8.2.1, Infrastructure, during deployment could increase the risk of road traffic-related accidents and injuries for both workers and community members.

Those most at risk for traffic-related accidents are often local citizens whose daily activities occur at the same time or in the same vicinity as the Proposed Action activities. The degree of health risk to the local communities and workers relates to the forms of local community traffic that exist on the same roads used by the Proposed Action (e.g., mixed-use traffic involving pedestrian, motorcycle, animals, etc.), the integrity of local road infrastructure, and driver behavior. Key risk factors for road traffic accidents that should be taken into consideration and mitigated in the deployment and operation phases of the Proposed Action include alcohol-impaired driving, distracted driving due to the use of handheld devices, speeding, low seat belt usage, and pedestrian use of roadways (*Puerto Rico Traffic Safety Commission 2014*).

Adherence to OSHA workplace standards, the implementation of the appropriate traffic congestion BMPs and mitigation measures, and the implementation of human health and safety BMPs and mitigation measures (see Chapter 11, BMPs and Mitigation Measures) could help to reduce the risk of road traffic-related accidents and injuries to both communities and workers.

Potential Noise-Related Health Impacts

Noise is measured in A-weighted decibels (dBA). Human exposure to long-term noise levels above 80 dBA is associated with an increased risk of hearing loss, and lower levels of noise exposure may be associated with non-auditory health effects, including sleep disturbance, increase in blood pressure, and increase in stress (*Evans et al. 2001; Babisch 2011; WHO 1999*). Sources of noise during deployment above ambient background noise and threshold distances are discussed in Section 8.2.13, Noise and Vibrations.

Worker health effects managed by OSHA are designed to prevent hearing impairment. If worker noise exposure is equal to or greater than 85 dBA for an 8 hour exposure, a hearing conservation program must be implemented (*OSHA 2015*). During deployment, construction activities that involve the use of heavy machinery could exceed 85 dBA (refer to Section 8.2.13, Noise and Vibrations).

For communities, a 5 dBA increase in noise above the ambient background is used to assess whether an impact is considered to be potentially significant (*IFC 2007; USDOT 2005; WHO 1999*). "Significant" in this context means the level of sound that a community is likely to perceive as an annoyance (*USDOT 2005*). The minimum increase in sound levels that most people can perceive is 3 dBA (*Bies and Hansen 1996*), which equates to a doubling of the sound power (sound is measured on a logarithmic scale). Use of a 5 dBA increase to assess whether a community might perceive a noise annoyance may not be accurate if noise levels in the community are already relatively high (e.g., above 65 dBA) (*USDOT 2005)*. In general, the "noisier" existing conditions are, the less additional noise is tolerated by the community (*USDOT 2006*). Higher noise levels and larger increases above existing noise levels are associated with increasing levels of stress responses. Noise-related disturbance and stress are subjective factors, and therefore there is no defined threshold at which a noise disturbance is considered to result in stress levels representing a measurable health effect. Best practice guidance suggests assessment of community noise based on perception rather than measured health outcomes (*USDOT 2005*), and on examining increases above baseline conditions (*IFC 2007*).

Providing further complication, the potential impacts of increased sound depend not just on the numerical increase in sound levels, but also on the intensity of the sound, the duration of the sound, and the sound setting (*WHO 1999*). Unexpected, short duration, high intensity sounds can have a worse effect than relatively steady sounds. Research suggests that humans appear to have capacity for adaptive response to typical sound levels in their environment; once adaptation has occurred, sleep patterns are not affected (*Stansfeld and Matheson 2003*).

Adherence to OSHA workplace standards, as well as the implementation of the appropriate noise and human health and safety BMPs and mitigation measures (see Chapter 11, BMPs and Mitigation Measures), could help to minimize the risk of human exposure to noise levels above health-protective levels.

Communicable Diseases

Communicable, or infectious, diseases are illnesses that result typically from infection by biologic agents (most commonly viruses, bacteria, and parasites) in a human or animal host. In Puerto Rico, human cases of the mosquito-borne diseases chikungunya and dengue have been reported in recent years. In 2010, Puerto Rico experienced its largest outbreak of dengue infections with 26,766 reported cases (*Departamento de Salud 2012*). In the first half of 2015, 739 probable and 29 confirmed cases of dengue were reported, and 79 confirmed cases of Chikungunya were reported in the territory (*PAHO/WHO 2015*). Community members and workers are both at risk for infection, particularly during the rainy season when the disease-vector mosquitos[2] are more prevalent. Construction activities considered under the Preferred Alternative that include land clearing and excavation may inadvertently create new bodies of standing water that can become mosquito vector-breeding sites, which could increase the risk of transmission of mosquito-borne illnesses to workers and community members.

With the implementation of the appropriate soil erosion control and human health and safety BMPs and mitigation measures (see Chapter 11, BMPs and Mitigation Measures), the risk of transmission of communicable diseases would be significantly minimized.

Radio Frequency Emissions

Interest has been expressed regarding the potential for human exposure to radio frequency (RF) emissions and the corresponding potential for adverse health effects. Regulatory limits for human exposure to RF emissions have been established by the Federal Communications Commission (FCC) under federal law. Over the years, the FCC has revised its standards and guidelines for protecting both workers and the general public—including limits for Maximum Permissible Exposure for transmitters covering the 700 megahertz (MHz) range and localized

[2] A vector is an organism that carries and transmits an infectious pathogen to another living organism.

absorption limits for mobile devices—and these have been upheld by the federal courts. FirstNet is a licensee of the FCC, and FirstNet's operations in the 700 MHz range are governed by these exposure limits.

There is some evidence of adverse health effects at levels below the current standards in a number of scientific studies; however, these studies are subject to a variety of uncertainties inherent in the epidemiological process. The preponderance of the evidence to date does not definitively demonstrate that there are adverse health effects caused by RF emissions, and there is still no single, plausible biological mechanism to indicate adverse effects. Scientific investigations into RF emissions and the possible effects of exposure on humans are inconclusive. These studies do not indicate any clearly reproducible trend and, consequently, there is insufficient and inconclusive data to make a definitive determination of effect of RF emissions on humans. Further discussion of RF emissions and their potential effects on humans is presented in Section 2.4, Radio Frequency Emissions.

8.2.15.4. Potential Impacts of the Preferred Alternative at the Programmatic Level

The following section assesses potential impacts associated with implementation of the Preferred Alternative, including deployment and operation activities.

Potential Deployment Impacts

As described in Section 2.1.2, Proposed Action Infrastructure, implementation of the Preferred Alternative could result in the deployment of various types of facilities or infrastructure. Depending on the physical nature and location of the facility/infrastructure and the specific deployment requirements, some activities would result in potential impacts to human health and safety and others would not. In addition, and as explained in this section, the various types of Preferred Alternative infrastructure would result in a range of *no impacts* to *less than significant* impacts at the programmatic level depending on the deployment scenario or site-specific conditions. Site-specific analysis may be required depending on the site conditions, the type of deployment, or any other permits or permissions necessary to perform the work.

Activities Likely to Have No Impacts

Of the types of facilities or infrastructure development scenarios described in Section 2.1.2, Proposed Action Infrastructure, the following are likely to have *no impacts* to human health and safety at the programmatic level under the conditions described below:

- Wired Projects
  - Use of Existing Conduit – New Buried Fiber Optic Plant: The pulling or blowing of fiber optic cable would be performed through existing conduit. Use of mechanical equipment would be limited to pulley systems and blowers. Hazardous materials needed for this work would include fiber optic cable lubricants or mechanical oil/grease, although these materials are expected to be used infrequently and in small quantities. These activities are not likely to result in serious injury, chemical exposure, or surface disturbances since work would be limited to existing entry and exist points, would be temporary, and

intermittent. It is anticipated there would be *no impacts* to human health and safety at the programmatic level.

- Use of Existing Buried or Aerial Fiber Optic Plant or Existing Submarine Cable: Lighting up of dark fiber would have *no impacts* to health resources at the programmatic level because there would be no ground disturbance or heavy equipment used to accomplish the task.

- Satellites and Other Technologies
  - Deployment of Satellites: FirstNet does not anticipate launching satellites as part of the deployment of the nationwide public safety broadband network (NPSBN); however, it could include equipment on satellites that are already being launched for other purposes. As adding equipment to an existing launch vehicle would be very unlikely to impact health and safety, it is anticipated that this activity would have *no impact* to those resources.

Activities with the Potential to Have Impacts

Potential deployment-related impacts to human health and safety as a result of the Preferred Alternative implementation would encompass a range of potential impacts that could occur as a result of exposure to hazardous materials in the air, water or soil; potential workplace or road traffic accidents that result in injury; potential health effects from exposure to noise, and increased infectious diseases transmission. The remainder of this section provides summary impact discussions for each development scenario or deployment activity.

- Wired Projects
  - New Build–Buried Fiber Optic Plant: Installation of a new buried fiber optic plant (i.e., new underground conduit) would include plowing, trenching, or directional boring and the construction of points of presence,[3] huts, or other associated facilities or hand-holes to access fiber could result in: disturbed soil and the potential for exposure to legacy contaminants in the ground, and the possibility for spills and soil and water contamination that could affect human health. Additionally, the use of heavy machinery and other vehicles around the construction area and on access roads would potentially impact human health through increases in air emissions and noise, as well as increased risk of workplace and road traffic accidents. Land clearing and any open areas that could cause rainwater to collect could increase the risk of transmission of mosquito-borne infections, in particular during the rainy season. Given that Puerto Rico is an endemic[4] area for chikungunya and dengue (mosquito-borne diseases), transmission to workers is a concern even if Proposed Action activities such as land clearing do not increase mosquito propagation at the site. BMPs and mitigation measures (see Chapter 11) could help to avoid or minimize the potential impacts.

[3] Points of presence are connections or access points between two different networks, or different components of one network.
[4] A disease or condition regularly found among particular people or in a certain area.

- New Build – Aerial Fiber Optic Plant: The build of an aerial fiber optic plant would require less soil disturbance and therefore the potential for exposure to legacy contaminants would be less than for a buried fiber optic plant. The use of heavy machinery still presents the possibility for spills and soil and water contamination, and air and noise emissions that could potentially impact human health, as well as possible workplace and road traffic accidents that could result in injury. BMPs and mitigation measures (see Chapter 11) could help to avoid or minimize the potential impacts.
- Collocation on Existing Aerial Fiber Optic Plant: Collocation of an existing aerial fiber optic plant is not expected to cause a sufficient level of soil disturbance that would result in the potential for exposure to legacy contaminants in the ground. The use of heavy machinery, while expected to be less than for new build, still presents the possibility for spills, soil and water contamination, and air and noise emissions that could potentially impact human health, as well as possible workplace and road traffic accidents that could result in injury. BMPs and mitigation measures (see Chapter 11) could help avoid or minimize the potential impacts.
- New Build – Submarine Fiber Optic Plant: The build of a submarine fiber optic plant would require less soil disturbance and therefore the potential for exposure to legacy contaminants would be less than for a buried fiber optic plant. The use of heavy machinery still presents the possibility for spills and soil and water contamination, and air and noise emissions that could potentially impact human health, as well as possible workplace and road traffic accidents that could result in injury. BMPs and mitigation measures (see Chapter 11) could help to avoid or minimize the potential impacts.
- Installation of Optical Transmission or Centralized Transmission Equipment: If installation of transmission equipment requires grading or other ground disturbance to install small boxes, huts, or access roads, there could be soil disturbance and the potential for exposure to legacy contaminants in the ground, and the possibility for spills and soil and water contamination that could affect human health. Additionally, the use of heavy machinery and other vehicles around the construction area and on access roads would potentially impact human health through increases in air emissions, noise, and an increased short-term risk of workplace and road traffic accidents. Land clearing and any open areas where rainwater collects could increase the risk of transmission of mosquito-borne infections, in particular during the rainy season. Given that Puerto Rico is an endemic area for mosquito-borne diseases, transmission to workers is a concern even if Proposed Action activities such as land clearing do not increase mosquito propagation at the site. BMPs and mitigation measures (see Chapter 11) could help to avoid or minimize the potential impacts.

* Wireless Projects
  - New Wireless Communication Towers: Installation of new wireless towers and associated structures (generators, equipment sheds, fencing, security and aviation lighting, electrical feeds, and concrete foundations and pads) or access roads could result in soil disturbance and potential for exposure to legacy contaminants in the ground. The

use of heavy machinery and generators presents the possibility for spills and soil and water contamination, and air and noise emissions that could potentially impact human health; and vehicles and heavy equipment present the risk of workplace and road traffic accidents that could result in injury. Land/vegetation clearing, excavation activities, or landscape grading could increase the risk of transmission of mosquito-borne infections. BMPs and mitigation measures (see Chapter 11) could help to avoid or minimize the potential impacts. For a discussion of radio frequency emissions, refer to Section 2.4, Radio Frequency Emissions.

  - Collocation on Existing Wireless Tower, Structure, or Building: Collocation would involve mounting or installing equipment (such as antennas or microwave dishes) on an existing tower which would not result in soil disturbance, however the use of heavy machinery and generators presents the possibility for spills and soil and water contamination, and air and noise emissions that could potentially impact human health. Vehicles and heavy equipment present the risk of workplace and road traffic accidents that could result in injury. Given no land clearing would be expected, the risk of transmission of mosquito-borne infections would be less although still a possibility for workers given the presence of chikungunya and dengue mosquito vector species in Puerto Rico. BMPs and mitigation measures (see Chapter 11) could help to avoid or minimize the potential impacts. For a discussion of radio frequency emissions, refer to Section 2.4, Radio Frequency Emissions.

- Deployable Technologies
  - Cell on Wheels, Cell on Light Truck, System on Wheels, Deployable Aerial Communications Architecture: The use of deployable technologies could result in soil disturbance if land-based deployables occur in unpaved areas, or if the implementation results in minor construction or paving of previously unpaved surfaces. The use of heavy machinery presents the possibility for spills and soil and water contamination, and air and noise emissions that could potentially impact human health; and vehicles and heavy equipment present the risk of workplace and road traffic accidents that could result in injury. Use of aerial vehicles would not involve telecommunication site work. Prior to deployment, and when not in use, the aerial vehicles could require preventive maintenance. Workers responsible for these activities may handle hazardous materials not limited to fuel, solvents, and adhesives. BMPs and mitigation measures (see Chapter 11) could help to avoid or minimize the potential impacts.
- Satellites and Other Technologies
  - Satellite-Enabled Devices and Equipment: It is anticipated that the installation of permanent equipment on existing structures and the use of portable devices that use satellite technology would have *no impact* on soil, water, air or noise resources (refer to Section 8.2.2, Soils; Section 8.2.4, Water Resources; Section 8.2.12, Air Quality; and Section 8.2.13, Noise and Vibrations), therefore the only potential human health and safety impacts considered are those associated with worksite or traffic-related congestion, which are anticipated to be minor and insignificant. Any use of satellite-enabled devices

and equipment would be within current regulated ranges/standards. For a discussion of radio frequency emissions, refer to Section 2.4, Radio Frequency Emissions.

In general, the abovementioned activities could potentially involve trenching and/or foundation excavation, which could expose soil containing contaminants either from existing industrial facilities or from legacy industrial activities and could potentially affect human health. In addition, the possibility for spills that result in soil and water contamination exists and could also potentially affect human health. The use of heavy machinery and other vehicles around construction areas and on access roads could potentially impact human health through increases in air emissions and noise, as well as increased risk of workplace and road traffic accidents that could result in injury. Site-specific analysis may be required depending on the site conditions, the type of deployment, or any other permits or permissions necessary to perform the work. Potential human health and safety impacts are described further below, and BMPs and mitigation measures that could help to avoid or reduce these potential impacts are discussed in Chapter 11, BMPs and Mitigation Measures.

Potential Exposure to Hazardous Materials Impacts

Based on the analysis of deployment activities, and adherence to OSHA workplace standards, potential health effects as a result of exposure to environmental hazardous materials are anticipated to be *less than significant* at the programmatic level. See Chapter 11, BMPs and Mitigation Measures, for a listing of BMPs and mitigation measures that FirstNet and/or their partners would require, as practicable or feasible, to help further avoid or minimize potential human health and safety impacts.

Potential Accident and Injury Impacts

Based on the analysis of deployment activities, and adherence to OSHA workplace health and safety standards, the risk of construction site, road, and other accidents and injuries to workers and communities is considered *less than significant* at the programmatic level. See Chapter 11, BMPs and Mitigation Measures, for a listing of BMPs and mitigation measures that FirstNet and/or their partners would require, as practicable or feasible, to help further avoid or minimize potential human health and safety impacts.

Potential Noise-Related Health Impacts

Based on the analysis of deployment activities, and adherence to OSHA workplace health and safety standards, potential health effects as a result of exposure to noise are anticipated to be *less than significant* at the programmatic level. See Chapter 11, BMPs and Mitigation Measures, for a listing of BMPs and mitigation measures that FirstNet and/or their partners would require, as practicable or feasible, to help further avoid or minimize potential human health and safety impacts.

Potential Communicable Diseases Impacts

Based on the analysis of deployment activities, the risk of transmission of infectious diseases for the workforce and community members is anticipated to be *less than significant* at the programmatic level. See Chapter 11, BMPs and Mitigation Measures, for a listing of BMPs and mitigation measures that FirstNet and/or their partners would require, as practicable or feasible, to help further avoid or minimize potential human health and safety impacts.

Potential Operation Impacts

As described in Section 2.1.2, Proposed Action Infrastructure, operation activities associated with the Preferred Alternative would consist of routine maintenance and inspection of the facilities. Any major infrastructure replacement as part of ongoing system maintenance would result in potential impacts similar to the abovementioned potential deployment impacts. It is anticipated that there would be *less than significant* impacts at the programmatic level associated with human exposure to environmental hazardous materials, impacts to human health and safety associated with the risk of road traffic, workplace accidents and injuries, noise exposure, and risk of infectious disease transmission. See Chapter 11, BMPs and Mitigation Measures, for a listing of BMPs and mitigation measures that FirstNet and/or their partners would require, as practicable or feasible, to help further avoid or minimize potential human health and safety impacts.

8.2.15.5. Alternatives Impact Assessment

The following section assesses potential impacts to soils associated with the Deployable Technologies Alternative and the No Action Alternative.[5]

Deployable Technologies Alternative

Under the Deployable Technologies Alternative, a nationwide fleet of mobile land-based and aerial communications systems would provide temporary coverage in areas not covered by the existing, usable infrastructure. There would be no collocation of equipment and no new construction associated with wired or wireless projects discussed above under the Preferred Alternative. Some limited construction could be associated with implementation such as land clearing or paving for parking or staging areas. The specific infrastructure associated with the Deployable Technologies Alternative would be the same as the deployable technologies implemented as part of the Preferred Alternative but would likely be implemented in greater numbers, over a larger geographic extent, and used with greater frequency and duration. Potential impacts to health and safety resources as a result of implementation of this alternative are described below.

[5] As mentioned above and in Section 2.1.2, Proposed Action Infrastructure, the Preferred Alternative includes implementation of deployable technologies.

Potential Deployment Impacts

As explained above, implementation of land-based deployable technologies would result in *less than significant* impacts to health and safety resources at the programmatic level if deployment occurs within public roads and some staging and land/vegetation clearing, excavation, or paving are required. These activities could result in the potential of on-site or road traffic related accidents involving workers and community members; disturbed soil and the potential for exposure to legacy contaminants in the ground; and air and noise emissions that could potentially impact human health; however, it is anticipated that the activities associated with the Deployables Alternative would have *less than significant* potential impacts at the programmatic level based on the analysis of deployment activities and adherence to OSHA workplace health and safety standards. If land clearing is required, depending on the area and time of year (rainy season), the risk of transmission of mosquito-borne infections could be a concern for workers given the local presence of chikungunya and dengue mosquito vector species. Site-specific analysis may be required depending on the site conditions, the type of deployment, or any other permits or permissions necessary to perform the work.

Potential Operation Impacts

As explained above, operation activities would consist of implementation/running of the deployable technology, and routine maintenance and inspections. It is anticipated that potential health impacts associated with human exposure to environmental hazardous materials in air, water, or soil, the risk of road traffic, workplace accidents and injuries, noise, and risk of infectious disease transmission would be *less than significant* at the programmatic level because of the small scale of likely FirstNet activities. Site-specific analysis may be required depending on the site conditions, the type of deployment, or any other permits or permissions necessary to perform the work. These potential impacts could be further reduced by the implementation, as practicable or feasible, of BMPs and mitigation measures (see Chapter 11, BMPs and Mitigation Measures).

No Action Alternative

Under the No Action Alternative, the NPSBN would not be deployed; therefore, there would be no associated construction or installation of wired, wireless, deployable infrastructure or satellites and other technologies. As a result, there would be *no impacts* to human health and safety because there would be no deployment or operation of the Proposed Action. Environmental conditions would therefore be the same as those described in the Affected Environment Section 8.1.15, Human Health and Safety.

8.3. References

8.3.1. Introduction

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8.3.2. Affected Environment

Infrastructure

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